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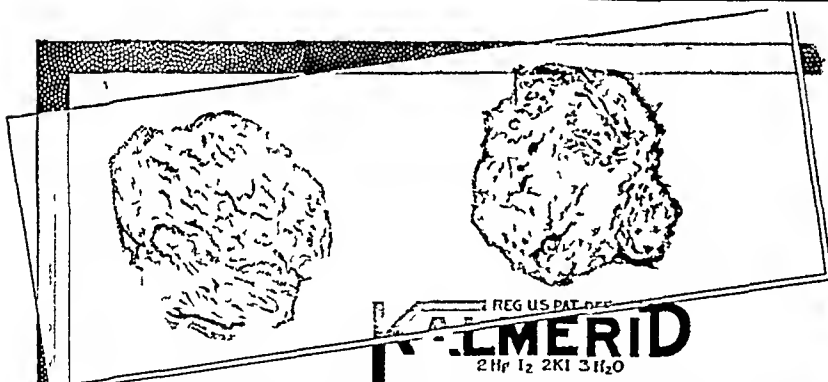
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The Editor has received from Dr John B Roberts a request that the following be published

Dr John B Roberts, author of the article on "Salvage of the Hand," published in the November number of the "ANNALS," desires to explain that four illustrations of useful appliances after amputation of the hand were copied, by permission, from the article of Dr Leo Mayer on "Amputations and Artificial Limbs" in *International Clinics*, vol iv, series 28, p 197 The illustrations, in the legends of which Dr Leo Mayer's name should be mentioned, are as follows

Fig 1 Man buttoning collar with two stumps

Fig 2 Apparatus for buttoning collar when the two hands have been lost

Fig 9 Artificial hand used for sharpening lead-pencil

Fig 10 Man using hammer between stump and chest

There were also two illustrations, namely

Fig 7 Reconstruction aide freeing scar from bone by massage

Fig 8 Solving a knotty problem,
which were taken from *Carry On*, the journal published by the Surgeon General of the U S Army These should have been credited to that source

The omission of credit for the use of these six illustrations occurred because of haste in getting out the "ANNALS," for November, and a consequent failure to give the author opportunity to supervise the printing of the legends Dr Roberts regrets the occurrence very much, especially because these illustrations formed an exceedingly important part of his article, for which credit should be given

In Fig 5, showing thumb taken from a poor photograph with outline reenforced with ink, the legend should read, "Thumb five months *before* repair by cutaneous transfer from thigh" This illustration was taken from a photograph of one of Doctor Roberts's patients

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SURGICAL PROBLEMS IN THE RECONSTRUCTION OF PERIPHERAL NERVE INJURIES *

BY CHARLES H. FRAZIER, M.D.

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IN SO FAR as concerns the injured of the American Expeditionary Forces, the surgical treatment of peripheral nerve injuries did not begin, with few exceptions, until the soldier became a patient in one of the General Hospitals on this side of the Atlantic. That the management of peripheral nerve injuries was a problem distinct from other surgical problems was recognized by the Surgeon General by the following. Under his direction twelve hospitals were designated as peripheral nerve centres to which all patients with these lesions were ordered transferred from the ports of debarkation. To each of these centres was assigned an officer, experienced in neurological surgery, and a consulting neurologist, and for each, a uniform equipment for the examination and treatment of nerve injuries was provided. As further evidence of the importance of the peripheral nerve problem, the Surgeon General appointed a Consultant in neuro-surgery and a Peripheral Nerve Commission.

In order that the results of the examinations, the methods of recording the clinical findings, and the clinical records themselves should be as nearly uniform as possible, æsthesiometers were designed for the various centres with which to test sensory disturbances and to record them in terms of grammes, and a special Peripheral Nerve Register was prepared and distributed with instructions as to how the various clinical findings should be recorded. With this preparation, the Peripheral Nerve Commission will be provided with the records of all peripheral nerve cases, which, from the standpoint of uniformity and completeness, should be as nearly perfect as is possible under the widely variant conditions in the different hospitals. While many examinations by competent neurologists were made on the other side, with few exceptions none of the records accompanied the patient to his destination on this side.

Up to the present time it is estimated that there are over three thousand peripheral nerve cases in the peripheral nerve centres. Of this

* Read before the American Surgical Association, June 17, 1919

number, the largest collection, 550, has been admitted to General Hospital No 11, which has been my headquarters, and my remarks on the surgical treatment will be based on my experience with this group. Of this number up to date 275 have been discharged, as recovered, to convalescent centres, 75 have already begun to recover function spontaneously, 150 have been or will be operated upon, and the remainder are under observation.

At the Second Annual Meeting of the Inter-Allied Conference, held in London, May 20, 1918, Professor G. Verga presented a report of 1000 cases in which only 160, or 16 per cent, had been operated upon. Comparative statistics are not of much value, since there may be wide variation in the character of cases in different centres, but I should regard 25 to 30 per cent as a reasonably conservative estimate of the proportion of cases in which operation is justifiable.

Only to those who have been burdened with the responsibility of conducting a peripheral nerve clinic will the magnitude and multiplicity of problems present themselves in their true proportion. The technic of examinations, the proper interpretation of the clinical findings, their proper evaluation, the decision for or against operation, the direction of treatment during the period of observation or recovery, apart from the difficulties of the operations themselves, these are all matters requiring time, experience and judgment.

It would not be possible in the allotted time even to mention many phases of scientific and practical interest, the peculiar sensory and motor phenomena in relation to partial and complete lesions and to recovery, the consideration of muscle tone and Tinel's sign, the trophic disturbances, the pathology of peripheral nerve lesions and the question of regeneration, so that I will restrict my discussion to those matters which relate solely to the surgical problems involved.

The first question for consideration is the time of operation. How long should one wait for evidence of spontaneous recovery? It has been my practice to wait at least until three months have elapsed from the date when the wound was healed, and in most instances, by observing this general rule, it is found that at least six months have passed since the injury was sustained. If at this time there are no signs of spontaneous recovery, on the one hand, and there is substantial evidence of a complete nerve interruption, whether or not this is interpreted as an anatomical division or a central neuroma, there are no grounds for further delay. One must not be deceived by the action of supplemental muscles which may compensate for the paralyzed muscle, as in one instance I recall when the ward surgeon reported to me six months after the injury that a patient with a complete median and ulnar paralysis could flex the wrist, and asked to have the operation postponed. An examination revealed the fact that the patient had learned how to flex the wrist with the short extensors of the thumb.

Assuming, however, that the wound heals promptly, as in wounds from machine-gun bullets, should an operation be advised, no matter how early, providing there is evidence of a complete nerve block? Captain Alexander, at the Alder Hey Military Hospital, Liverpool, maintained that cases sutured within four months of the injury do not do as well as those sutured after the sixth month, probably because degeneration was not complete in the peripheral segment. Whether this be true or not, the mere fact that many cases do not show signs of spontaneous degeneration until about the sixth month, is, I believe, sufficient justification for deferring the operation at least that long. I am quite aware of the fact that the results of primary suture are better than those of delayed suture, *ergo*, the sooner the operation, the better, but I also know that it is quite impossible to distinguish with absolute certainty by any single clinical sign or syndrome between a complete but transitory physiological block and a complete anatomical division. If the general dictum, as advocated by some, were observed, namely, to operate as soon as the wound permits, with evidence of complete physiological division, many a case would be explored which eventually would have recovered spontaneously, and resection and suture would not only have postponed the time of eventual recovery, but might have been totally unsuccessful.

As to matters purely technical, certain general principles should be observed. The tourniquet should not be used routinely, but in the exceptional case with massive cicatrization of the tissues, much time may be saved in the preliminary dissection if hemorrhage is controlled with a tourniquet. This should be removed before resection or suture, in the interval all bleeding is controlled. Liberal incisions are essential, as the nerve must be exposed and often liberated far above and below the lesion. Traumatism to the healthy portion of the nerve is to be avoided, and to this end I have found it advantageous to operate under a constant spray of saline solution, which keeps the field clear, and if sponging be necessary, use small, moist, cotton pledgets. The preliminary dissection is the most tedious of surgical procedures. It may be carried out with a small, sharp scalpel, or, as I prefer, when the nerve is embedded in scar tissue, with small curved eye tenotomy scissors and fine fixation forceps. Unless one begins well above and below the lesion, the identification of the different nerve trunks, from one another or from thrombosed vessels, particularly in the upper third of the arm, may be quite impossible. Only with continuous scrutiny will one avoid severance of important ram

While the preliminary dissection or disentanglement of the lesion is tedious and time-consuming, it is the choice of procedure and the method of dealing with the lesion where experience and judgment count. This brings me to the consideration of the various operative procedures, neurolysis or liberation, resection and suture, and the various suggestions for dealing with large defects.

As the least complicated, neurolysis will first be considered. In proportion to the total number of operations, we have performed a neurolysis in 20 per cent. The figures correspond to the experience of other clinics, although in some, as in a series recorded by Verga, there were 80 neurolyses in 160 operations, or 50 per cent, and in the series of Delangière (*Bull et Mem Soc de Chir de Paris*, 1918, xlv, 522) there were 113 liberations in 245 operations. It is not always easy to make a decision in favor of neurolysis as against suture. When there is a constricting band, with grooving of the nerve, or when there is compression and a narrowing of the lumen over a greater distance, when there is evident pressure from callus, a spicule of bone or aneurism, there admits of little doubt. Neurolysis is clearly indicated (and one should always give the nerve the benefit of the doubt) when it responds promptly to faradic stimulation. But in a number of cases, and I have often found this the case with the musculospiral, in addition to compression from external causes, there is an associated sclerosis or fibrosis of the nerve, which of itself may inhibit regeneration.

It has become almost a routine practice to recommend resection and suture in the presence of a spindle-shaped neuroma. However, bearing in mind clearly the pathology of the neuroma, it must be acknowledged that the neuroma *per se* is not an absolute barrier to the growth of neuraxes. It represents, to be sure, an effort by Nature towards regeneration against difficulties, but not always ineffectually. The development of a neuroma in cases undergoing spontaneous recovery is not uncommon, and it is not infrequent after suture or transplantation. Huber found in a neuroma, resected in this clinic from the sciatic nerve, such an active growth of neuraxes that he considered spontaneous recovery in this instance would not have been out of the question. If the presence of a neuroma cannot be the indisputable criterion, the final decision must rest upon the time which has elapsed between the injury and the operation and upon whether the nerve responds to faradism. The decision will in all cases be more or less arbitrary. If there are signs of total loss of function at the expiration of six months, resection and suture are justifiable. Joyce (*British Journal of Surgery*, vol xx, No 23, 1918) takes exception to this recommendation, the resection of a spindle-shaped neuroma is not justifiable, he says, unless failure has resulted from a neurolysis capsulectomy at which the thickened portion of the sheath has been removed. In this conclusion I cannot concur.

The technic of neurolysis should include the freedom of the nerve from the cause of compression, the cicatricial band or the more extensive scar tissue, dissecting the nerve free from the callus in which it is engaged, such as one often finds in musculospiral palsies. We sometimes find massive fibrous infiltrations of the sheath itself, and an attempt should be made to remove as much of this thickened portion of the sheath as possible, but not to the point of laying bare the fasciculi. In the reconstruc-

PERIPHERAL NERVE INJURIES

tion of the wound, the ideal and natural bed is an intermuscular plane or a plane between a muscle sheath and the deep fascia. To surround the nerve with flaps taken from adjacent muscles is not good surgery, since the reparative process in the healing of the muscle wound is attended with such cicatrization as of itself to threaten compression of the nerve. At least, this is the conclusion to which I have been led from observations I have made at secondary operations. I believe it entirely justifiable, too, in selected cases, and I refer to those of massive cicatrization in the arm, to transfer the nerve to a plane between the deep and superficial fascia, by this procedure the nerve is totally isolated from a field of connective tissue, which may inhibit the reparative process.

The great problem of peripheral nerve surgery is that involved in resection and the bridging of defects. The bringing into apposition of the divided segments with appropriate sutures is a matter of minor consideration if one observes certain accepted principles of nerve suture, but in gunshot wounds resection is a matter of necessity and to such an extent usually that approximation cannot be effected without resort to one method or another of bridging the defect. These methods now to be reviewed include posture, nerve stretching, nerve flaps, suture à distance, tubulization, lateral anastomosis, implantation-suture, transposition, some of these may, I think, be discarded with a few words, because, whatever evidence there may be from the experimental laboratory, the clinical evidence does not justify their adoption as acceptable procedures.

The so-called *flap-operation* as proposed by Letievant is not deserving of consideration, since, when the central and peripheral flaps are reflected, the ends of the respective flaps would not be in alignment and this would interfere with the down growth of neuraxes. The modification of this flap operation in which a flap is taken from a healthy nerve is objectionable chiefly because it involves sacrificing a portion of a normal nerve. The operation would be practicable only when two large trunks were in proximity, as in the upper arm. But one would hesitate in a case of ulnar paralysis, where the disability will often not affect deleteriously the patient's earning capacity, to sacrifice either the median or musculospiral.

As Huber says, *suture à distance* is more of academic than practical interest. In his laboratory experiments, success was attained in two out of three instances by interposing bundles of coarse catgut between the divided ends, but I know of no successful attempts in human surgery.

Tubulization, as a means of bridging defects, has been used extensively both in the laboratory and in the clinic, but there have been so many clinical failures that I have scrupulously avoided it. With Prussian pertinacity the Germans clung to this method in the early stages of the war. The so-called Edinger's tube, the formalized calf artery, was repeatedly employed, sometimes filled with blood serum, sometimes with agar-agar, but always, and I have seen the reports of 100 cases, with failure. Not only was there no evidence of regeneration, but on later

examination the gap had increased and bulbous formations were found on either end of the divided nerve

In this connection a word may be said as to the use of protective sheaths both in neurolysis and nerve suture. I have refrained from any protection to the liberated or sutured nerve with fascia, fat, calf arteries or any other material, since there is every reason to believe that devitalized tissues, such as the foregoing, will stimulate connective tissue formation and thus militate against, rather than facilitate, nerve regeneration at the line of suture. A pedicle flap of muscle, fascia, or fat might overcome the objection to the use of these so-called protectives, but it has been my belief that the nerve sheath itself, if carefully approximated with sutures, offers adequate protection from the invasion of connective tissue.

Lateral anastomosis, as practiced by Hofmeister (*Beitrage zur Klin Chir*, 1915, 96, 329), has no merit whatsoever. In his report, which contained the notes of 24 operations, the results of the operations were not included. It is merely assumed that a neighboring healthy nerve serves as a favorable and convenient medium for the down-growth of neuraxes. If the terms lateral anastomosis and lateral implantation are synonymous, I quite agree with the wholesale condemnation this method has received, Tinel speaks of it as always useless and often mischievous, Moynihan, as to be sharply condemned, and Benisty, as illogical.

In order to avoid confusion, we must, I think, coin another term for an operation, similar to lateral anastomosis, in that the central or peripheral stump alone or combined are sutured into an adjacent nerve, but differing in this essential respect, namely, that a portion of this adjacent nerve is sacrificed. This is virtually a nerve suture and the term I would suggest as appropriate would be "implantation-suture."

I believe this operation has a field, limited though it may be, chiefly in the arm with large defects in the ulnar or musculospiral, not only because a healthy nerve is accessible, but because certain portions of the median may be sacrificed with only slight and transitory sensory loss. While on physiological and anatomical grounds I have regarded this so-called implantation-suture as justifiable in selected cases, I have not yet had a case in my clinic for which I thought it was appropriate. But looking over the literature, I found several instances in which it had been practiced with success. Thus in one of Joyce's cases, an ulnar lesion (*British Journal of Surgery*, January, 1919, p. 426), while almost one-third of the circumference of the median nerve had been sacrificed, the sensory loss was entirely recovered in course of time, and in twenty-four months there was partial sensory and motor recovery in the ulnar area. Souttar (*British Journal of Surgery*, October, 1918) employed the method in two cases (Case 54 and Case 56), in one, he implanted the lower segment of the musculospiral nerve which was attached to the centre of the front of the median, the fibres of which were divided. Ten

months later there was faradic response in the extensors of the wrist. In the second case there was strong synergic action of the extensors of the wrist twelve months after the operation. It was noteworthy that Joyce cut the inner third of the median nerve and Souttar the external anterior fibres, and in both instances there was only transitory sensory disturbance.

On two occasions, one with a defect in two nerves, another with a defect in three, I have resected five centimetres of the humerus. This is a radical procedure and should be a court of last resort. When practiced, the operation should be divided into two stages, at the first liberating the nerves and resecting the humerus. This necessitates an incision on both the inner and outer aspects of the arm and after connecting the neuromata of the several nerves with strands of silk for later identification the wounds are closed, and the second stage is not undertaken until one is assured of uncomplicated wound repair. In one of the two cases, because of the time required at the first sitting in disentangling the injured nerves, the ulnar, median and internal cutaneous, the bone was not resected until a second sitting and the nerve finally sutured at a third.

The susceptibility of nerve trunks to stretching offers a valuable auxiliary measure for dealing with defects. Weir Mitchell in his classical monograph called attention to the tolerance of nerves to forcible stretching, and we know that, without the risk of rupturing its fibres, two to four centimetres of a defect may readily be made up. Nerve stretching with posture will often suffice to secure apposition in a defect of 7 to 8 cm. There are two ways of stretching the nerve. One as just described in the course of the operation, the other over a more extended period. The latter will be called for only in exceptional instances, and I do it in this way. If, after the nerve is liberated, it is evident that the defect cannot be bridged except with a graft, I pass heavy silk sutures through the bulbs and draw them as closely together as possible with the forearm or leg flexed. During the succeeding four weeks the limb is gradually brought into a position of extension and by this process the nerve is stretched. At a second operation, by bringing the limb again into flexion, approximation of the segments after resection is possible. This technic is particularly serviceable for injuries of the arm where two or more nerves are involved.

Nerve transposition as an aid to bridging defects is most helpful and is applicable to the ulnar and musculospiral, the former more frequently than the latter. The course of the musculospiral I have shortened by passing the peripheral segment between the biceps and brachial anticus and uniting it with the central segment on the inner aspect of the arm. The ulnar is isolated from its normal location and transposed to the flexor aspect of the forearm. I can see no advantage in following Stiles' recommendation to tunnel beneath the pronator radii teres and there are many disadvantages. In the first place, the deeper course is the longer when the forearm is in flexion, as it usually is when the nerve is sutured,

and secondly, the branches to the flexor carpi ulnaris and flexor profundus digitorum are sacrificed. These ramæ may both be conserved providing one splits them up as far as may be necessary beyond the point at which they join the parent trunk. Even though it may be more important to restore function to the intrinsic muscles of the hand, it need not be done at the expense of the ulnar flexor supply. The third situation in which transposition may be of service is the knee. Here in large defects of the external popliteal the distance from the bifurcation of the sciatic to the head of the fibula may be shortened by transposing the nerve to a plane superficial to the ham-string tendon with the limb in flexion.

With large defects advantage must unquestionably be taken of favorable positions to secure apposition without tension, such as flexion of the forearm or knee, adduction of the arm, inclination of the head toward the affected side.

As a last resort only should one resort to a transplant, not that there is not enough clinical evidence at hand to warrant the procedure, but the percentage of successful sutures is greater with direct suture than with the graft. In dealing with 150 nerve lesions at General Hospital No. 11, we have used a graft to repair the defect on seven occasions, as follows:

1 musculospiral	defect 7 cm	Transplant, musculocutaneous (leg)
1 brachial plexus	defect 7 cm	Transplant, musculocutaneous (leg)
1 ulnar	defect 5 cm	{ Transplant, musculocutaneous (leg)
		{ Transplant, dorsal branch of ulnar
1 ulnar	defect 14 cm	Transplant, musculocutaneous (leg)
1 external popliteal	defect 8 cm	Transplant, musculocutaneous (leg)
1 median	defect 8 cm	Transplant, musculocutaneous (leg)
1 brachial plexus	defect 5 cm	Transplant, musculocutaneous (leg)

It is too soon to report ultimate results, but in two of the seven there is already evidence of regeneration. In a brachial plexus lesion the fifth cervical nerve was replaced with a transplant of 7 cm. from the musculocutaneous of the leg and already there is a faradic response in the deltoid muscle. In a second case, a 5 cm. defect from the level of the wrist and upwards, there is tingling on pressure over the graft, 3 cm. below the upper line of suture. In every instance an auto-graft has been used and usually the musculocutaneous, although according to one's convenience, the sural, the radial, or, with a defect in the nerves above the elbow, the internal cutaneous may be used. Two to four cables, according to the size of the nerve, should be used, and the sutures should be introduced in either end of the transplant at the proper interval before it is severed from its connection. According to Huber, whose investigations during the past two years have been most illuminating, the fascial cuff should not be used and we have observed this injunction. Huber believes the auto-transplant should always be given preference, but in a recent communication he writes that he has obtained favorable results with homo-transplants stored in vaseline and in liquid

petrolatum In his experiments with homo-transplants, stored in 50 per cent alcohol, the neuraxes have grown 3 cm into the distal segment

In reckoning how much of the nerve is to be resected, as many fasciculi as possible should be spared By palpation, inspection, and with the clinical notes, one can determine whether the entire trunk or but a part need be sacrificed, but when in doubt electrical excitation is helpful, stimulating first the various aspects of the nerve through the sheath and, if still in doubt, after the sheath has been opened By this means I have been able to conserve healthy fasciculi which otherwise would have been sacrificed

For the ultimate success of suture, the most essential factor is the presence of healthy fasciculi, free from the grasp of cicatricial tissue Granted this, the prognosis may be good in spite of a clumsy suture One is always tempted to keep the defect within reasonable limits, fearing the difficulty in securing apposition But if after the preliminary sections, distal and central, the cut section does not present healthy fasciculi without scar tissue, slice after slice should be removed until the desired picture is obtained One soon learns to recognize these conditions, when, upon section, the ends of the fasciculi project a little beyond the cut surface, one is reasonably sure that the section has been made above and below the invasion of scar tissue *Per contra*, if the cut section is smooth, and the fasciculi do not project, it is because they are engaged in scar tissue and a higher or lower level must be inspected Successive sections should not be made at greater intervals than 2.5 mm, since at this distance the whole picture may change I have found a safety-razor blade preferable to either a scalpel or ordinary razor blade The sheath of the nerve must be grasped on either side to steady the nerve while the section is being made

One tension suture of chromic catgut, through the entire thickness of the nerve, one centimetre from the free end, with four to eight epineural sutures of the finest silk, suffices to keep the sheath in apposition The tension suture should not be tied until the epineural sutures are in place and then just fast enough to bring the fasciculi in contact; if too tight, the fasciculi will be crushed, if too loose, a blood clot may form in the interspace Second in importance only to the necessity of securing a healthy segment for suture is the avoidance of undue tension Every resource must be availed of to enable one to bring the segments into apposition without undue tension

We have dealt in but fragmentary fashion with the problems of nerve reconstruction There are many minor points in technic, as affecting individual nerves, that are deserving of consideration Enough has been said, however, to emphasize the complexity of the problem and the important part played by judgment and experience Nothing has been said of tendon transplantation for those cases in which nerve suture has failed or is difficult, or where spontaneous regeneration has been arrested The

two situations in which tendon transplantation is particularly adaptable are (1) in the residual paralysis of the extensor longus digitorum, when the patient has recovered full power in all the muscles supplied by the musculospiral, with the exception of the common extensors to the fingers, and (2) in the residual paralysis of the anterior tibial with foot-drop. Tendon transplantation should be resorted to in both these lesions and no patient should be discharged until an attempt has been made in this way to supplement the paralyzed muscle.

The after-treatment is a matter of vital consideration, massage, galvanism and later faradism, properly selected exercises, these must be continued faithfully and persistently until voluntary movement has returned. Secondary operations in some instances will be inevitable.

The Surgeon General has given every consideration to this branch of reconstructive surgery. Within two months practically all cases requiring surgical treatment will have been operated upon. Recovery of function is a slow process and it remains to be determined how long after the operation the patients will be retained in government hospitals.

The final chapter of peripheral nerve surgery cannot be written until two years hence, at least, so far as concerns the wounded of the American forces. The final test of superiority claimed for one method or another must be based upon the end results. As one of the most important functions, it remains for the Peripheral Nerve Commission, acting under the direction of the Surgeon General, to follow up all cases that have or will be discharged from the General Hospitals and prepare a final report based upon the end results.

LYMPHOSARCOMA OF THE MESENTERY

By LESLIE LAWSON BIGELOW, M D

AND

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OF COLUMBUS, OHIO

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SOLID tumors of the mesentery are not of frequent occurrence In 1897 Harris and Herzog¹ collected 56 cases from the literature and added another one of their own In 1899 Herzog² reported a lymphosarcoma arising in this region In 1905 Bowers³ described a mesenteric lipoma This same year Vance⁴ collected 28 cases from the literature of the preceding five years Since then isolated cases have continued to appear in the literature so that now there are approximately 100 cases on record

Lymphosarcoma is in itself not a common lesion Symmers⁵ reports that in the 5500 autopsies conducted at Bellevue Hospital during the last ten years only twelve instances of lymphosarcoma were encountered In the fifty-seven mesenteric tumors collected by Harris and Herzog, there are possibly three lymphosarcomas, although only one is so listed In Vance's collection, there are two specimens recorded as lymphosarcoma and one as a small round-celled sarcoma Royster⁶ reported in 1911 two cases of round-celled sarcoma of the mesocolon It is possible that some of these tumors listed as round-celled sarcoma were actually of lymphoid origin Occasionally lymphosarcoma of the mesenteric or retroperitoneal nodes has gained access to the literature by reason of some striking complication such as the production of chylous ascites The following case in which there was found a lymphosarcoma of the mesentery would appear to be of sufficient interest to justify its publication

CASE I—E M, boy, aged six years, was brought to the hospital on the 19th of July, 1919, for a palpable, visible tumor of the abdomen, associated with recurrent attacks of abdominal "cramps" The family and previous history were negative Nine weeks before examination the patient was kicked in the abdomen by his brother A week later another injury was received in the same region by a fall over a baby carriage From this time the patient had suffered with severe attacks of "cramps" in the abdomen, during which he doubled up with pain and broke out in a cold sweat There was never any nausea or vomiting and nothing abnormal was noted in the urine or stools At first these attacks occurred two or three times a week Of late they have been more frequent, the abdomen has become noticeably enlarged and the child has become pale, weak, listless and does not care to play There has been no cough or loss of appetite There has been a progressive loss of weight

Physical examination shows a thin, sallow-complexioned, poorly

nourished white boy apparently five years of age. The head, neck, heart, lungs, extremities, and external genitalia are normal. There is no œdema of the feet or ankles. There is evidence of recent wasting of the subcutaneous tissues. The abdomen is full, slightly protuberant and round in contour, except in the right lower quadrant, where a tumor is seen. There is no bulging in the flanks. The superficial veins are enlarged and quite prominent over the front and sides of the abdomen, the lower part of the front of the chest wall, and the upper parts of the thighs. The abdomen is thin walled, soft and generally tympanitic, except over the tumor mass in the right lower quadrant. The edge of the liver is felt at the costal margin. The spleen is not palpable. The presence of free fluid was not determined. The tumor filling the right lower quadrant is firm, elastic and irregular in outline. Its inner margin reaches the median line and its upper margin is above the level of the umbilicus. It is not attached to the abdominal wall and can be readily displaced laterally and to a less extent vertically. There is no tenderness upon manipulation. Temperature and pulse were normal. Examinations of the urine and stools were negative. Blood examination. Hæmoglobin, 90 per cent, red cells, 4,000,000, white cells, 11,000, polymorphonuclears, 81 per cent, lymphocytes, 17 per cent, mononuclears, 7 per cent, and eosinophiles, 1 per cent.

Operation was refused and the child was removed from the hospital. The attacks of pain continued with progressive loss of weight and strength. The patient was readmitted for operation seven weeks later. The tumor had increased in size, extending nearly to the costal margin and for a distance of two fingers' breadths to the left of the median line. Percussion yielded a tympanitic note above and to the outer side of the tumor. No attempt was made to determine by inflation the relation of the large bowel.

The rapid growth of the mass with loss of weight and strength bespoke malignancy, and the age of the patient's sarcoma. The mobility of the tumor, pronounced at the first examination, the negative urinalyses, the situation mesial to the ascending colon seemed to deny a sarcoma of the kidney. Sarcoma of the small bowel was ruled out by the freedom from digestive symptoms during the period of over ten weeks since the presence of the tumor was noted. A diagnosis of retroperitoneal sarcoma was made.

Under ether anæsthesia, the abdomen was opened through a vertical right rectus incision extending from the costal margin nearly to Poupart's ligament. An irregular mass the size of a grape fruit presented. The ascending colon lay behind and to its outer side. A segment of small intestine passed diagonally from above downward and outward over the inner third of the tumor. There were no adhesions. An incision was made in the peritoneal covering of the tumor beginning an inch away from the intestinal loop passing over it with the intention of securing a section for microscopical examination. The overlying gut and the inner leaf of the peritoneum were readily stripped from the mass, however, and it was dissected

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out with surprising ease, a portion of the peritoneal covering on its outer side coming away with it. Several vessels were tied and the large gap in the outer leaf of the mesentery was united with a continuous suture. The viability of the intestinal loop that overlay the tumor was questioned, but as the inner layer of the mesentery seemed to be intact, it was hoped that the blood supply, though damaged, would still be adequate. Resection of the intestine was therefore not attempted. This proved to be an unfortunate decision: the child died with symptoms of obstruction four days later, and autopsy revealed a gangrenous area involving the gut for a distance of about 6 cm. Resection of the intestine with anastomosis might, therefore, have resulted in an operative recovery, though the numerous small nodules remaining in the base of the mesentery would probably have determined a fatal issue ultimately.

Pathological Report Surgical Path 15436 The specimen is a roughly lobulated mass covered by a glistening membrane. It measures (after fixation) $14 \times 10 \times 8$ cm. Upon section, the cut surface presents a very soft and cellular appearance. About one-third of the mass is hemorrhagic. This area is that next to the raw surface described on the outside of the mass. The mass appears to be limited by its coverings and gives the impression of having resulted from the fusion of several lymph-nodes.

Microscopically, the mass is composed of small round cells supported upon a delicate reticulum of connective tissue. The tumor cells are round and contain a nucleus which is relatively large and eccentrically placed. The nuclei contain rather coarse chromatic granules. The cytoplasm stains well with the hematoxylin. The cells resemble very closely the ordinary lymphocyte and serve to classify the tumor in the lymphoblastoma group. Its regional character and invasion of capsule characterize it as a lymphosarcoma. The growth is rich in poorly formed, thin-walled blood-vessels. These are closely surrounded but not invaded by the tumor cells. Certain areas show marked necrobiotic changes. The cells are swollen and their nuclei have become indistinct. In many areas there is a frank necrosis. Sections from the hemorrhagic areas show an abundance of free blood-cells mingled with the tumor cells.

Autopsy Notes No 2625 (abstracted) —The peritoneal cavity presents fresh fibrinous adhesions which mat the intestines together. There is also a small amount of free yellowish fluid. The omentum is bound to and encloses a loop of the small intestine. The appendix is normal. In the ileum, 10 cm above the ileo-cæcal valve, is a gangrenous area involving the gut for a distance of 6 cm. The liver is covered with a fibrinous exudate. Its cut surface is pale. The gall-bladder appears normal. The genito-urinary system is not worthy of note. The retro-peritoneal nodes are slightly enlarged. The base of the mesentery is filled with a number of nodular masses, the largest of which is 3 cm in diameter. Histologically, the structure of the nodes is lost and the whole node is packed with cells of the lymphoid series.

Discussion —The mortality following operations for solid tumors of the mesentery with or without resection of the intestine is high. In a series of twenty-seven cases, collected by Vance, there were sixteen recoveries and eleven deaths—a mortality of 41 per cent. Seven of these tumors were sarcomata, and only one of the patients recovered. Unquestionably the mortality is higher in these instances in which the tumor

proves to be malignant than in the benign forms of fibroma and lipoma which make up the greater number of the reported cases. The surgical procedure, whether enucleation alone or combined with intestinal resection, cannot be determined until the tumor is exposed. Resection requires more time, adds to the operative risk, and should be avoided whenever possible. In those cases in which the tumor bulges the mesentery chiefly on one side and the overlying gut is consequently placed laterally, it may be possible to enucleate the growth without dangerous interference with the blood supply. If the overlying gut is more centrally placed, the tumor bulging both leaves of the mesentery equally, or if the gut is adherent to the growth at its wall and involved in the process, resection should be proceeded with at once. Successful cases where enterectomy was combined with the removal of a mesenteric sarcoma have been reported by Harris and Herzog, Sawyer, Mathews, and others. The length of the intestine removed has varied from one-half an inch to eight feet and two inches. That the question of resection is not necessarily determined by the size of the tumor is evidenced by the case cited by Bowers where a fibroma weighing thirty pounds was successfully enucleated.

The case presented here adds one to the few of mesenteric sarcoma and the long list of sarcomata in other regions where the onset of the symptoms and the development of a tumor have followed a definite history of trauma. What, if any, etiological significance this trauma may have had, we do not undertake to say. The growth made its appearance within the time limits set by Sand. It is, of course, possible that a careful examination given an injured region may disclose the presence of a previously existing tumor of which the patient was unaware, and it is conceivable, also, that an existent impalpable tumor might take on a more rapid growth following an injury to the part, thus becoming palpable. In this case, the patient suffered from abdominal "cramps" for several weeks before the "lump" was noticed.

There is nothing distinctive in the history of the subjective symptoms to suggest the diagnosis. Abdominal pain may be present and severe enough to suggest biliary, renal, or appendicular colic, or it may be entirely absent. There may be slight nausea and constipation, but, as a rule, the patient is free from gastric and intestinal disturbances—a helpful point in the differentiation from sarcoma originating in the intestine, where, according to Spease, nausea, vomiting, alternating periods of constipation and diarrhoea with abnormal findings in the stool are early and prominent symptoms.

Objectively the patient is weak, anæmic and has lost in weight recently. The abdomen harbors a tumor more or less centrally placed, nodular, and freely movable. This free mobility is the most important single sign. It is said that no other abdominal tumor possesses it to the same degree. If, in addition, the presence of a loop of intestine passing over the mass can be demonstrated, which cannot be displaced and maintains a fixed relationship to the tumor through several examinations, a presumptive

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diagnosis of mesenteric tumor is warranted. The tumor is tense and elastic and is often regarded as a cyst. Several instances are on record where a trocar was introduced, after the growth was exposed by laparotomy, before its solid nature was recognized. Effort should be made to determine the relation of the large bowel to the growth. If the tumor develops in the mesentery of the small bowel, the ascending and descending colon will each be found in its respective loin, external to the mass while the transverse colon will lie above it. In the differential diagnosis confusion has existed with cysts of the ovary, pancreas, tumors of the liver, enlargements and displacements of the kidney, hydrops of the gall-bladder, and growths of the bowel itself. Because of their rarity these growths are little considered in the diagnosis of abdominal tumors. From a practical viewpoint, the important thing is the recognition of the presence of a tumor and its prompt removal.

Kundrat and Paltauf were the first to give clean-cut descriptions of lymphosarcoma and to distinguish it from other malignant tumors of the lymph-nodes. In 1907 MacCullum studied eight cases which corresponded to this group. So that there is now recognized a definite form of neoplasm arising in lymphoid tissue and composed of lymphoblastic cells which do not remain within the confines of the involved nodes but infiltrate the adjacent tissues. Distant metastasis is rare, but all of the nodes of the region may be more or less involved. These regional types of growths can be subdivided as follows:

1 Cervical, axillary and inguinal 2 Thoracic (a) thymic, (b) peribronchial 3 Abdominal (a) gastro-intestinal, (b) intestinal, (c) mesenteric, (d) retroperitoneal

The case here reported conforms to the established picture of a regional lymphosarcoma. The character of the blood-vessels easily accounts for the hemorrhage and degeneration present. This is in contradistinction to the thoracic type in which the rarity of degeneration and softening has long been emphasized. The size of the mesenteric mass as compared with the involved retroperitoneal nodes leaves little doubt that the tumor arose in the mesentery.

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RECURRENT NEPHROLITHIASIS *

BY OTIS FLOYD LAMBSON, M D.
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IT is rather surprising that this important subject of recurrent nephrolithiasis has received comparatively little attention both in the literature and in the research laboratories, and we have as yet no definite preventive methods for the recurrence of stones in the urinary channels

Personally, I must confess that a very much smaller portion of my limited knowledge of kidney stones, primary or recurrent, I have gathered from the trying school of personal experience While the larger part I have obtained from the thoughts and observations of men who possess not only the necessary mental capacity, but also the institutional opportunity for original research work

To-day we are privileged to enjoy the hospitality of such distinguished men and their remarkable institution which has turned more than any other its enlightening searchlight on the various puzzling and annoying problems that cross the path of a practitioner of medicine and surgery

In my professional activities I meet no patient with greater timidity than one that comes to me with a recurrent kidney stone I am very timid when confronting such a patient and my words of ultimate result of the operation are indeed few and carefully selected I am well aware that I am dealing with a disease whose true etiology is not definitely known, and the treatment, surgical or medical, or both, may and may not remove the cause of his peculiar kidney activity

In order to give the patient with kidney stones as efficient treatment as possible his family history, mode of living, occupation, and his environment must be carefully studied If the case be a recurrence the findings of the first operation and the chemical composition of the stones removed may throw some light on the obscure etiology of his trouble

The general etiology of recurrent nephrolithiasis cannot differ materially from that of primary stones and it is therefore worth while for us to bear in mind the different causes of renal calculi that have been advanced at different times

Unfortunately, we have as yet no definite etiology of this disease We can only speak in general terms Some attribute the formation of stone to some obscure chemical change in the composition of the urine, others emphasize the influence of microorganisms, of injury, and inflammatory diseases I believe, as stated by Doctors White and Martin, that the formation of kidney calculi is due to the precipitation in the kidney tubules

* Read before the Association of Residents and Ex-Residents of the Mayo Clinic, October 8, 1919

or pelvis of the solid constituents of the urine, this precipitation always taking place on an organic base, that may be mucus, epithelial cells, blood-clot, or colloid material. A coagulation necrosis of cells caused by interference with the circulation favors deposition of lime salts. All concrements, whether they be the size of a grain of sand or of a goose-egg, have a distinct albuminoid framework upon which the constituents of the urine are deposited.

Diathesis possesses a distinct influence upon stone formation which is commonly associated with the uric acid, the oxalate, or the phosphatic diathesis. Ebstein holds that the excess of urates, oxalates, or phosphates in the urine does not form stone by direct deposition in the excretory canals in the pelvis of the kidney, but that these ingredients favor a coagulation necrosis of cells, which furnishes the organic framework essential for such calculus formation, the same effect may be produced by local sepsis.

Those who advance chemical theories as causative agents speak of the influence of heredity, race, climate, diet, drinking water, drugs and intoxicants and faulty metabolism as contributing factors. Even incidences of gout and rheumatism have been held responsible for kidney stones. Against this theory an English army officer of considerable experience in the tropics speaks of the unusual prevalence of stone in the urinary tract among the inhabitants where gout or rheumatism is practically unknown. The cause of this prolific calculus formation he attributes to the native peculiar diet which is rich in albumin and phosphates and lacks the necessary quantity of salt, which is essential with a vegetable diet.

Against the theory that renal calculi are of bacterial origin, Cabot and Crabtree in a joint paper state that "the relation of infection to stone formation is not a factor of great importance, for were such the case, stone in the kidney would be far more common in the female than it is in the male, following the well-known fact that kidney infection is more common in women than in men." In one of my cases of recurrent kidney stones I was told that for several generations many male members of the family had had sometime or other some such kidney trouble—yet none of the female members had been affected. It is generally accepted that renal calculi are more common in men than in women.

A great many, like Albarran, consider primary stones to be of non-bacterial origin, but the secondary or recurrent types to be of bacterial origin. Ransohoff finds that primary stones consist of uric acid, urate of sodium and ammonium, oxalate of lime, carbonate of lime, and lastly of cystin or xanthin, which are deposited from the urine without any changes of an infective nature, but he states that secondary calculi, which consist for the most part of phosphate of lime, develop only in a kidney already the seat of infection.

It has been observed that as a complication of spinal-cord lesions secondary stones may occur. Injuries of the kidney and mild pyelitis

have been suspected of promoting the formation of stone by shedding products, namely, epithelial detritus, fibrinous deposits, or small blood-clots, which may serve as a focus for the deposit of lime-salts

It is a very much over-used custom to place the blame on heredity when through lack of intelligence or diligence we are unable to find the true cause of a disease. I believe that heredity is a secondary factor—a mere tendency which may be aggravated by geographical location and mode of living. If different generations of one family remain in the same environment, eat the same foods, and drink the same water, and are exposed to identical causes, we may expect to find the same pathological condition in each generation.

One of my patients was raised in a part of Scotland where the family had resided for three generations. Kidney stones are known to have occurred in each one, paternal grandfather and two uncles died of this disease. One of his brothers has had occurrences of renal calculi. He states that this was one of the most common diseases of that territory, and he holds it due to their drinking water, which he describes as "heavily charged with lime." He left that territory early in his youth and came to western Canada. He was aware of no kidney trouble until thirteen years ago, when he became engaged in railway construction and went to a territory which had very much the same quality of water as his native home in Scotland, and within a short time he began passing white stringy material which had the appearance of fine sand. On drying this substance it looked very much like plaster of Paris. The frequent attacks of renal colic undoubtedly were due to the passage of this substance and gravel which has persisted ever since. Though he took an autogenous vaccine in 1911 for three or four weeks, the same symptoms and attacks of renal colic continued. X-rays in 1910 did not show any stones present in the kidney or ureter. Later he received A. G. No. 3 irrigations of the pelvis of both kidneys, but this also had no influence on the attacks.

In 1916 he joined the Canadian forces and went to France. While there symptoms became more severe than ever before and he was forced to leave the service in September, 1917. He then consulted Doctor Fenwick, of London. X-rays taken at that time showed a large stone in his left kidney but none in the right. He was operated by Doctor Fenwick, and one large stone was removed from the left kidney. In spite of very rigid routine of living and a meat-free, limited diet, he had in a few months a second crop of kidney stones. This time X-ray demonstrated both kidneys to be involved, showing one large recurrent stone in the left and three in the right. It almost appears that once the kidney mechanism becomes used to the act of such calcification in some cases it is difficult to prevent this process of stone formation.

In October, 1918, he consulted me. In passing ureteral catheter no obstruction was encountered. Urine examination gave specific

gravity, 1016, alkaline reaction; traces of albumin, but no sugar. Microscopic examination showed pus present in the urine of both kidneys. Radiographs verified the previous findings. Immediate operation was suggested and performed, when I removed three stones from the right kidney. As these stones were caught in the calyces, it did not seem wise to attempt their removal from the pelvis, but a small incision was made into the kidney. After the removal of the stones a small rubber tissue drain was introduced into the pelvis of the kidney for drainage. I explored the right first, as I thought that possibly it might be necessary to remove the left kidney at the second operation.

Three months later I removed from the left kidney a large stone which was embedded deeply in one of the calyces. Analysis of the stones removed at these two operations showed that they were composed of mostly calcium, magnesium, phosphate and carbonate. Therefore, as an after-treatment, I have had the patient drink very freely of water and for the past five months distilled water exclusively. In the meantime I have allowed him a rather general diet including meat. Unless I have been successful in removing the direct cause of this peculiar action of the kidney, either through the surgical interference or through the subsequent regulated diet, I am prone to believe that in course of time we will find a second and perhaps a third crop of stones. So far I am happy to state that there seem to exist no signs of kidney stones. He has no renal colic and the urine has shown considerable improvement in its chalky appearance and composition. The pus has entirely cleared up and the X-rays show no evidence of recurrence.

The surgeon cannot shake off all responsibility for a recurrence, but at the time of the operation must consider the possibilities of his work being the very cause for a future recurrence. Often in order to abstain from cutting into the kidney tissues, undue effort is made to remove a large stone through a small opening into the pelvic cavity and the stone is crushed or small fragments are scraped off and remain in the kidney. On such concretions, regardless of their size, the constituents of the urine may be deposited and a new set of stones formed.

During operation a well-lodged stone in its removal may injure the tissues, especially that of the ureter, and give rise to ureteral strictures, which will later promote the formation of ureteral stones.

Though we find many a stone in the whole of the urinary tract unassociated with any infection pre- or post-operative, yet I am inclined to believe with Hunner that the occurrence of an infection favors stone formation, especially of the recurrent type, by intensifying inflammation of a mal-functioning kidney, causing perhaps more serious and epithelial exudate and by decomposing the urine and setting free its solid constituents which may serve as substance for another set of stones. Thus I cannot help but speak emphatically of the importance of "good surgery."

in its full sense, if we are not to contribute to the recurrence of renal calculi

In order to do our part as surgeons well we are partly dependent on the pre-operative correct localization as well as accurate diagnosis. Then our approach must be direct and the removal of stones as clean as possible. Though little has been written about the preventatives of this disease, much has been said about the technic of the operation. In the hands of a well-trained surgeon the operation entails a very small mortality risk. But when we come to consider the fact that various operators have placed the percentage of recurrent stones in the kidney at from 10 to 48 per cent, it behooves us to look about most earnestly to find out why this big divergence in statistics. I think that the investigators who reported 48 per cent recurrence gathered cases from hospital statistics where there were a number of operators doing the surgery and perhaps, therefore, there was not a uniform surgical technic as in the institution where the small percentage of recurrence was made.

I feel that it is within my subject to speak of the importance of the different diagnostical means at hand at the present time. In no branch of medicine is the diagnostical value of X-ray more firmly established than in the examination of the urinary tract. Yet surgeons cannot afford to absolutely rely on the picture, but cystoscopic examinations must help him in the correct interpretation of the X-ray picture. There is no medical field where an absolute cooperation between the cystoscopist, rontgenologist and the surgeon is as imperative. I am putting the importance of the surgeon last, as his work depends on the painstaking and correct diagnosis of the pathological condition.

The correct interpretation of radiographs of the kidney is among the most difficult, as the kidneys themselves are only slightly more resistant to the rays than the surrounding abdominal organs lying in the path of the rays. The liver, which often shows greater resistance, is apt to obscure the upper pole of the right kidney.

Calculi, due to their chemical make-up, offer more resistance to the rays and allow a less amount of ray penetration and are therefore more easily detected, yet often they escape recognition, or when recognized they are difficult to be definitely localized. If they are composed of mostly calcium oxalate they are easily detected, but the uric acid calculus is very permeable to the rontgen rays. Fortunately, such are rare, but generally stones are made up of different ingredients and never of just one. Still, in spite of this fact, they may escape or mislead the expert rontgenologist. Calcified glands, small fecal concretions, especially when surrounded with gas, may lead us to suspect them to be renal calculi.

When stone in the right kidney is suspected, it is well to bear in mind its possibility of being a gall-stone, therefore it is wise to carefully scrutinize the location, the form and the character of the suspected shadow. Gall-stone shadows are located higher up, on or above the eleventh rib. They are generally identified by their concentric layers.

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and density Still there are a great many that escape recognition Fortunately, we have other diagnostical means at our disposal which may help to clear up all doubt in at least a large percentage of these cases Pyelography has proven itself to be of great value, as it will demonstrate any considerable change in the outline of the renal pelvis, which is apt to be the case if obstruction of its normal outlet is present

In short, I wish to emphasize the importance of a cooperative examination that must precede operative treatment

The localization of kidney stone and its removal are necessarily only the first steps toward the possible cure of the disease A great deal may depend on the after-treatment, which must be a preventive treatment The points that I wish to make in regard to the treatment of recurrent nephrolithiasis are

- 1 That we cannot hope to prevent the recurrence of this disease unless we know more of its true etiology

- 2 Careful study of the history of the patient in all its different aspects and thorough examination of the urine and chemical analysis of the stone may determine the post-operative treatment

- 3 Thorough flushing of the urinary channels through drinking freely of water, preferably of distilled water, may help in the dislodgment and removal of any possible nucleus of future stones This treatment must be continued for a considerable period even after the urine has completely cleared up

- 4 Faulty or incomplete surgery by leaving in the pelvis fragments of stones may contribute toward a recurrence of nephrolithiasis

HOURL-GLASS BLADDER REMARKS ON THE RESECTION OF THE BASE OF THE BLADDER FOR TRANSVERSE SEPTA *

BY JOHN R. CAULK, M.D.
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ABNORMALITIES of the bladder are becoming more and more frequently observed since our diagnostic facilities have been so much improved. I wish to report two cases which seem to offer enough clinical interest to be worthy of presentation before this association. The term "hour-glass bladder" is rather confusing, since the cause of the deformity seems to assume so many pathological variations. Really, there are but few hour-glass bladders described. Fuller's cases, which were reported before this association in 1900, Pagenstecher's cases, as well as those of Pielcke, Fothergill and Passow, the anatomical reports by Orth, and the one of Squier seem to comprise about all the cases presented. The case of Squier, of course, gave an hour-glass appearance, but was due to a diverticulum, the others were hour-glass deformities due to the contraction of the bladder itself. Anatomically those bladders are definitely hour-glass. The cases which I wish to report are anatomical and physiological hour-glass bladders. By this I mean that there is a physiological contraction of the bladder over the dome in the same segment with the transverse septum of the base.

In the cases of Pagenstecher and Fuller the contraction was anterior to the ureteral orifices, and these orifices were in the upper chamber. Mine showed a partition across the base of the bladder, about one inch behind the interureteric bar, which divided the bladder base into two compartments, the ureteral orifices being in the anterior or lower chamber, similar to the cases of Fothergill and Passow, cited by Legueu. My excuse for presenting these cases is to call attention to the surgical technic which was employed for the removal of these partitions.

Various degrees of hypertrophic bands are frequently seen in the obstructed or in the neurogenous bladder, and most are coincidental rather than causal factors in the production of symptoms, and I dare say that most of them are of a congenital nature with a superimposed pathological process. One of my patients had several congenital deformities, *viz*, hare-lip and hypospadias, the other one had not. Hypertrophies of the interureteric bar are not uncommon, and incisions by cautery or by knife either suprapubically or endovesically have been reported.

CASE I—M. B., Milwaukee, Wis., male, aged forty-two years.
Complained of frequent painful urination, painful defecation, pain in the bladder and rectum.

Family History—Negative

* Read before the American Association of Genito-Urinary Surgeons, June 16, 1919

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Past History—Had scarlet fever and diphtheria as a child, with no complications. Frequent bed wetting until nine years of age. Until thirty-five years he was in fairly good health. In 1908 suffered a nervous breakdown and shortly after this had a protracted fever which was supposed to be typhoid, but which impresses one as having to do with urinary toxæmia. He gave no history of venereal diseases. In the patient's younger days he had been mentally quite active and alert, was an editor and magazine writer.

Present Illness—Since 1908 the patient has been extremely nervous, has had a great deal of digestive disturbance, mental depression, drowsiness, and headaches. At times would fall asleep at his desk, and has even fallen asleep riding a bicycle. Two months after the beginning of this illness, he began to have trouble with his bladder, *viz.*, frequent, painful urination, at first with blood. This was treated by internal medicines and irrigations and improved. In 1912, after suffering constantly with his bladder, he had another severe nervous attack. We catheterized and a pint of residual urine was removed. Since this time he has suffered constantly with pain in the bladder and rectum, general depression, drowsiness, weakness, exhaustion, frequent chills and fever. An interesting feature of his history is that he noticed that he could urinate much more freely lying down than he could standing, and later could urinate only while flat on his back. Since 1915, that is, a year before admission, he had complete retention, and since has been on catheter life. Catheterization has always been painful and frequent, often every fifteen minutes. He has been diagnosed by several men as having a nervous lesion.

Examination—Patient is a pale, poorly nourished individual, very drowsy. Eyes normal and general neurologic examination negative. Has a hare-lip, but not a cleft palate. Heart, lungs and abdominal examination negative. There is a balanic hypospadias, otherwise external genitalia are negative. Rectal examination shows slight relaxation of the sphincter, prostate and vesicles chronically inflamed, but small, lumbar puncture, negative, phenosulphonphthalein test less than 40 per cent. Blood examination normal, except for slight loss of the hæmoglobin. X-ray of the spine, negative, proctoscopic examination shows normal mucosa but there is a note that the bowel seems fixed anteriorly.

Cystoscopic Examination—Complete retention of urine, bladder capacity 500 c.c. Cystoscopic shows a slight median bar, moderate relaxation of the internal sphincter, marked trabeculation of the bladder, hypertrophy of the interureteric bar, about three-fourths of an inch behind the interureteric bar is an elevated band which runs transversely across the base of the bladder, fans out on each lateral wall, and has a concavity anteriorly, giving the bladder a double pouch, the bas-fond in front and another pouch behind. Mucous membrane over the bladder bar is pale.

With negative neurologic findings, except for a suggestive internal orifice and slight relaxation of the rectal sphincter, I decided

to do a suprapubic operation, designed to remove both the median bar obstruction and the transverse band across the bladder, which seemed to project at least one-half inch. This operation was done in February of 1916. Mid-line suprapubic incision under gas and ether showed the bladder to be quite large. It was freed thoroughly. This step, the mobilization of the bladder before attempting resection, is very important in all operations for bladder resection. Upon opening the bladder it was found that there was very little obstruction at the internal orifice, this band, previously alluded to, was quite marked, being tense and firm. The interesting finding was next encountered. The bladder wall back of the band was very redundant and freely movable. By grasping it with a mouse-toothed forceps, the bladder mucous membrane, well back on the base, could be carried over the bar and pressed into the neck of the bladder, offering a satisfactory explanation for the initial attacks of retention and for the peculiarity which the patient had in not being able to urinate standing as well as lying. The surgical procedure adopted was a resection of an elliptical area across the base of the bladder four inches transversely and about three inches antero-posteriorly. This removed the bar which was in the anterior part of the resected portion and took away enough of the redundancy to allow the bladder wall to be brought together without tension. The mucous membrane seemed to be particularly freely movable over the musculature in this posterior pouch. The septum was very fibrous, hard and extended through the bladder wall with perivesical adhesions, so that there was some difficulty in removing it from the surrounding tissue. This was done without complications, and after the posterior bladder wound had been closed the bladder really had the appearance of a normal one. Ureter catheters were then passed well up in each ureter with an attempt to keep the bladder dry. I may say that I do this very frequently in bladder resections and have found it a very valuable adjunct. Catheters are brought out through suprapubic drainage tube. The median bar was then removed, the bladder closed anteriorly around a tube, two drains passed around the bladder to the base in the neighborhood of the suture line, and a small drain in the space of Retzius. The suprapubic wound closed as usual. The patient made a prompt and satisfactory recovery, having not the slightest complication. The tissue drains were removed from forty-eight hours to four days, catheters removed the fourth day, suprapubic tube on the eighth day. At the end of four weeks the wound had healed and the patient was passing his urine naturally. I have just received a letter from him stating that he is having no trouble with his bladder and is in better health than he has been for years. As he describes it, he is "full of pep."

CASE II—Mrs. W., Fort Worth, Texas, forty-two years of age, consulted me in March, 1919, complaining of painful, frequent urination without relief, pain in the right kidney and bladder.

Family History—Negative

Past History—Always healthy except for attacks of appendicitis

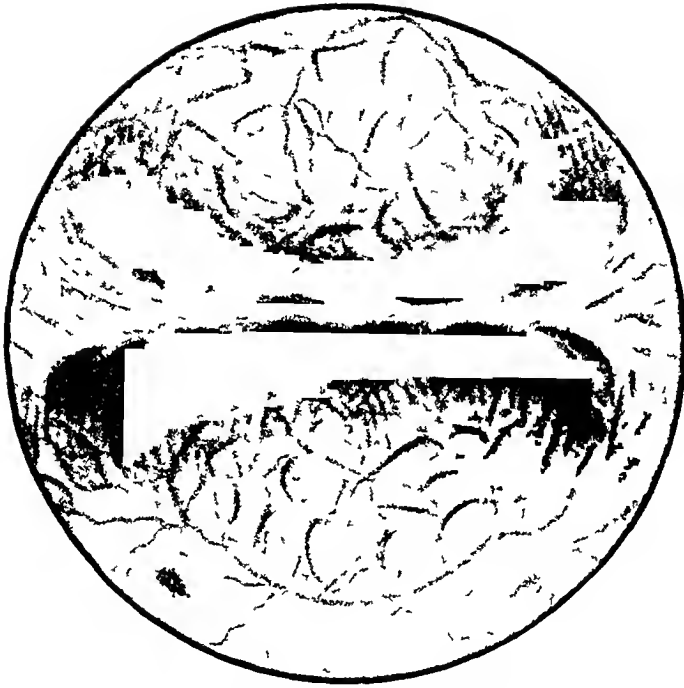


FIG. 1 —Showing congenital band of scar across base of bladder and patency of right ureteral orifice



FIG 2 —Hour-glass or dumbbell bladder Regurgitation of fluid up ureter into kidney pelvis



FIG 3 —Bladder after operation Liberty Bell bladder

HOURL-GLASS BLADDER

from sixteen to twenty-five years of age when appendix was removed with cure Menstrual history, negative Married in 1907, had one child fifteen months after marriage Difficult labor, torn, repaired with excellent result One miscarriage since

Present Illness—First bladder trouble started four months after marriage Onset sudden with frequent burning urination, terminal hæmaturia Was sick one month Associated with this she gives a typical history of pelvic inflammatory disease for which she was treated without surgery No further bladder trouble for four years All during her married life she says she has used vaginal suppositories of bichloride to prevent conception and they have always burned her In 1912 she had another sudden bladder attack which lasted for six months At this time she had to get up five to seven times at night to urinate Bladder was treated by local instillations, irrigations and urinary antiseptics At this time the patient was found to have no kidney involvement and she had never suffered any kidney symptoms Following this she was well until June of last year, when another sudden attack occurred, she was treated with AgNO_3 instillations by her doctor, and in a few days improved Then following an instillation in the bladder, given by a nurse, she had a sudden acute pain in the bladder and became unconscious, later had a chill, high fever, vomiting, pain in the right kidney, which became severe The temperature ran as high as 105 degrees This lasted intermittently for two weeks At this time she had an acute retention of urine and a large slough of bladder mucous membrane was removed through the meatus Patient was sick at this time in the hospital for ten weeks Since then has never had relief from her bladder and has had intermittent pain in the right kidney with pyuria Urinates every fifteen minutes to one hour in the daytime and every hour at night, and suffers paroxysms of bearing down pain in the lower abdomen Since last summer has experienced considerable pain in the rectum and straining She feels that her bowels must move when her bladder empties, and *vice versa* Recently has had an almost constant aching pain in the right kidney with intermittent fever Has lost but little weight

Examination—Patient well nourished, good color General examination of heart, lungs and abdomen, negative, nervous system negative, patient voids very frequently and seems to suffer pain and straining Blood examination, normal, blood nitrogen, 56 mgm to 100 c c X-ray, negative

Cystoscopic Examination—Bladder capacity restricted, holds only 150 c c, bladder very spastic, urine grossly clear but contained scattered pus cells and a few colon bacilli on centrifugation Internal orifice somewhat irregular, general fine trabeculation of the bladder, trigone slightly elevated, right side somewhat retracted, right ureteral orifice was open and gaping, and looked almost like the orifice of a diverticulum Left ureteral orifice normal, no ulceration of the bladder, no evidence of tuberculosis About one inch back of the trigone is an elevated partition that completely crossed

the base of the bladder and fanned out on either side, causing a slight puckering of the bladder laterally, with a depression in front of and behind it (Fig 1)

Ureter catheters passed easily to both kidneys. The urine from each was clear, the right containing a few pus cells. Intravenous phthalein appeared in three minutes on both sides, first fifteen minutes on the right, 11 per cent, on the left, 12 per cent, second fifteen minutes, on the right, 8 per cent, on the left, 10 per cent. Pyelogram showed a hydronephrosis and hydroureter on the right.

Cystogram done later showed the interesting hour-glass bladder (Fig 2), also showed the patent ureteral vesical valve with reflex up the right ureter and a complete filling of the right kidney pelvis, which was described by Kretchmer. It also shows the haustrations of the ureter from spastic contraction, which are frequently seen and which could be mistaken for strictures, but which can be relaxed by atropin. This patient was operated on April 3, suprapubic cystotomy with resection of the base of the bladder containing the transverse band. This partition was very hard, almost cartilaginous and extended completely through the wall of the bladder and was adherent to the rectum which explained her rectal symptoms. The same operation was done as in the previous case with the natural exception of the prostatic condition. Patient had a very satisfactory convalescence, the wound healed the twenty-third day. At the present time she is entirely relieved from all her pain in the bladder, rectum and kidney. She has frequent urination, although she has gone two hours in the daytime and three hours at night. The hour-glass contraction in this case was produced by the band on the base of the bladder with a spastic contraction of the muscle of the dome, there was no anatomical pathological change in the anterior wall of the bladder. Cystogram made six weeks after the operation shows but slight evidence of constriction and less of the hour-glass appearance (Fig 3)—now a Liberty Bell bladder.

SUMMARY

I am convinced that incising these bands would not have effected a cure, as they implicated the whole bladder wall, similar to the Hunner ulcer, and nothing short of complete resection can hope to cure the patient. The operation is not hard, can be performed from without, but must be carefully done when approaching the external coat of the bladder. Hemorrhage can be easily controlled. The first case is of interest on account of the resection of such a large amount of redundant bladder wall, and is an illustration of a prolapsus which has been described by Villier, Streubel, Vary and others.

I wish to emphasize the importance of free mobilization of the bladder before resection, the value of ureter catheter drainage in bladder resection, the need of complete removal of such transverse partitions and not

HOURL-GLASS BLADDER

temporizing with mere slit operations, the importance of vesical spasm in the neighborhood of inflammatory areas which in Case II served to magnify the hour-glass contraction, and finally, the protective value to a kidney of removing causes of vesical spasm in the presence of a patent ureteral vesical valve

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ELEPHANTIASIS AND THE KONDOLEON OPERATION

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ELEPHANTIASIS and elephantoid conditions are brought about by the mechanical obstruction of the lymphatics or veins of the dependent part, added to which is associated the presence of microorganisms, whether it be a *filaria nocturna* or the streptococci. In certain tropical countries the hypertrophy and fibromatosis of the hypoderm is brought about no doubt most frequently by the filaria, but in the Gulf and South Atlantic States we find the streptococci the exciting cause. According to Matas,¹ the hysto-pathological elements necessary to complete the picture of elephantiasis are (1) a mechanical obstruction or blockade of the veins and lymphatics of the region, usually an obliterative thrombo-phlebitis, lymphangitis or adenitis, (2) hyperplasia of the collagenous connective tissue of the hypoderm, (3) gradual disappearance of the elastic fibres of the skin, (4) the existence of a coagulable dropsy or hard lymph oedema, and, (5) a chronic reticular lymphangitis caused by the secondary and repeated invasion of pathological microorganisms, usually of the streptococcal type. With this viewpoint of its pathology we can lay aside all of the old ideas of tropical types and streptococcal type, etc. This better understanding of its pathology has led us more nearly than ever to the prospects of curing these unfortunates through the medium of an operation, which has been credited to Kondoleon,² of Athens, Greece, who first published his method in 1912. The oldest surgical treatment suggested for elephantiasis was that proposed by Carnochan in 1851, which consisted in the ligation of the main artery of the limb, the femoral or external iliac, with a view of diminishing the oedema. Next came the method of excising wedge-shaped areas by Mikulicz, Von Eiselsberg, Kaposi and others. None of which were, however, satisfactory. The idea of establishing a lymphatic communication between the diseased and normal area seems not to have been original with Kondoleon, for in 1908 we find Sampson Handley³ published his method known as "Lymphangioplasty," which consisted of passing long threads from the diseased area to healthy areas with the hope and expectation of establishing new lymphatic channels along the lines of these silk or linen threads. This has been much practiced throughout the civilized world, not only for elephantiasis, but for other conditions, such as the drainage of internal hydrocephalus suggested by Sharpe,⁴ and many of the elephantoid conditions. However, Madden,⁵ Ibrahim and Ferguson, of the Egyptian government school of medicine at Cairo, showed very conclusively by their experiment that the force of gravity as well as the fibrous constriction forming about these newly formed lymphatic tubes, defeated their object and ultimately caused them

to become fibrous bands. Finally, Handley⁶ himself concludes that his procedure was not applicable to elephantiasis in his Hunterian lecture on the surgery of the lymphatic system. Lanz⁷ in 1906 attempted to establish drainage from the œdematous area to healthy tissue by a long incision through the skin and fascia lata (which acts as a shelf between the superficial and deep lymphatics) by planting pedunculated strips of this fascia lata into trephined openings in the femur. In addition many smaller openings were made in the fascia lata. Oppel⁸ and Rosanow⁹ also contributed to this idea of draining by planting flaps of the fascia lata into the deep muscles and extended their operation to the lower limb as well as to the thigh (Fig. 1). Evolving his ideas then evidently from those whose efforts had preceded his, but with the same fixed purpose to establish a lymphatic communication between the healthy infra-aponeurotic tissue and the diseased obstruction and hypertrophied supra-aponeurotic tissues, Kondoleon excised a large strip of the fascia lata throughout the diseased area and stitched the edges of the aponeurosis to the underlying muscle, with most gratifying results. That scar tissue will form in this gap is obvious, but the newly forming, anastomosing lymphatics and veins will establish themselves so abundantly and quickly in so large an area that they seem to resist this constricting influence. This he first reported in 1912 and later in 1915. In 1913 Matas and Gessner report this operation, being the first to perform it in America. Later Royster,¹⁰ Hill,¹¹ Barber,¹² Moschowitz,¹³ and Sistrunk reported success with it. Sistrunk¹⁴ especially, whose large experience with it in the Mayo Clinic has added much to its refinement.

CASE I—Mrs. M. presented herself on April 18, 1919, with elephantiasis of the right limb. Was born at Swansboro, Georgia, in 1894 and lived there until eighteen years of age, when she moved with her family to Savannah. The swelling of the limb began when she was seventeen years old. She was married when she was fifteen. Had a severe childbirth with pelvic infection and milk-leg at seventeen. Since then the limb has gradually become larger. During this period of eight years she has had several attacks of elephantiasis fever at which time there was an erysipelatous eruption with sudden onset of chill, fever and aching throughout the body. When she was twenty she had a laparotomy done and both tubes removed for a pelvic inflammatory condition. At the age of twenty-one she was examined for the filaria and she said it was found by one of the internes in one of the Savannah hospitals. A careful study of the blood a few months later was negative, as was also our own investigation. In January, 1918, silk threads were passed from the skin down through the deep fascia and out, numbers of these being inserted as setons from the ankle to the hip with the hope of relieving the lymphadenoma. This was after the method described by Handley in 1908 and which he himself has since abandoned. The scars of this procedure can be seen in the photographic plate. It failed abso-

lutely to relieve her (Figs 7 and 8) She came of normal parents Father died of valvular heart disease at the age of fifty-six Mother living and healthy, aged fifty-five Three sisters and three brothers living and healthy One sister died of childbirth During childhood she had measles, mumps, chicken-pox and whooping-cough Vaccinated against small-pox No hook-worm infection Menstruation established at thirteen Suffered dysmenorrhœa constantly until birth of the child

Physical Examination—Stout blond, aged twenty-five years Weight, 148 Height, 5 feet 4 inches Skin, mucous membrane, nose, throat and reflexes, normal Had Riggs's disease badly several years ago, but apparently cured Chest and abdomen, negative Extremities, right limb much enlarged

Measurements—Thigh, 26 inches, above knee, 22 inches, at the middle of the calf, 20 inches, and the ankle, 11 inches

Blood—Smears for filaria, negative (through several nights' study) No malarial parasites Hæmoglobin, 85 per cent Differential count shows polymorphonuclears, 73 per cent, lymphocytes, 25 per cent, eosinophyocytes, 2 per cent White blood-corpuscles, 13,000, red blood-corpuscles, 5,000,000 Stool examination, negative Wassermann blood, negative

Operation—Under ether anæsthesia, 1 hour and 40 minutes Two incisions were made from the trochanter major to the external malleolus (after Kondoleon's method with modification by Sistrunk) These incisions each began at the trochanter and diverged in the thigh until they were a distance of 10 cm apart, approaching each other slightly again at the lateral aspect of the knee to a distance of 6 cm apart, and then diverging again to a distance of 10 cm apart at the centre of the foreleg, gradually converging again to meet at the external malleolus (see Figs 3 and 4) The subcutaneous tissue at the edges of the skin incisions was undercut for a distance of 4 cm and the skin flaps held back (Fig 5), when the fascia lata was reached a strip of it was removed about 6 cm wide throughout the entire length of the incision This mass, consisting of skin, subcutaneous tissue, and fascia lata, was removed *en bloc* (Fig 6) In Kondoleon's original operation, no skin was removed It is of a great deal of advantage, however, as Sistrunk¹⁵ has shown, to remove about the same amount of skin as one does of the superficial fascia in order that there will be no redundancy of the skin (Fig 6) The skin edges were approximated and sutured after careful hæmostasis A similar flap was removed from the inner aspect of the limb from the trochanter minor to the internal malleolus, except that it was of smaller dimensions (Fig 4) The gross weight of the tissue removed was 6 pounds Patient showed quite a little shock after operation, but reacted nicely Both incisions healed by primary union Patient, however, was very anæmic and developed a double pyelitis and a diarrhœa during her convalescence, which protracted it The pyelitis was readily relieved by washing the renal pelvis with silver nitrate solution, 1 per cent The diarrhœa was found to be due to anacidity and disappeared under large doses of

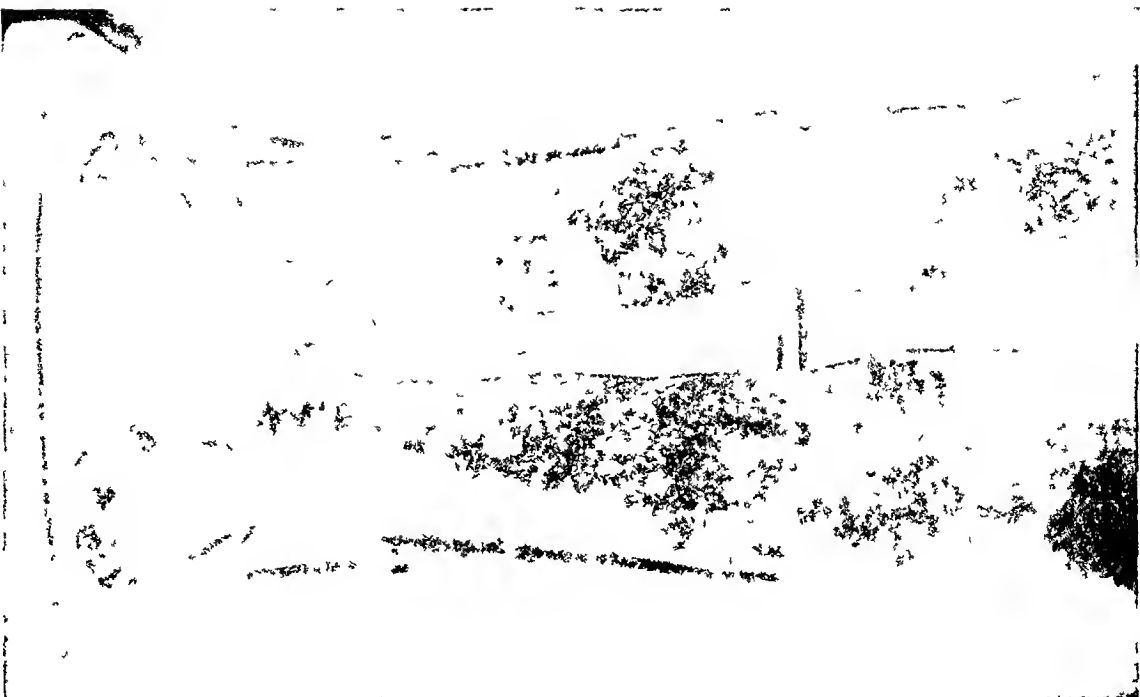


Fig 1—Rosenow's case before operation



Fig 2—Rosenow's case after operation

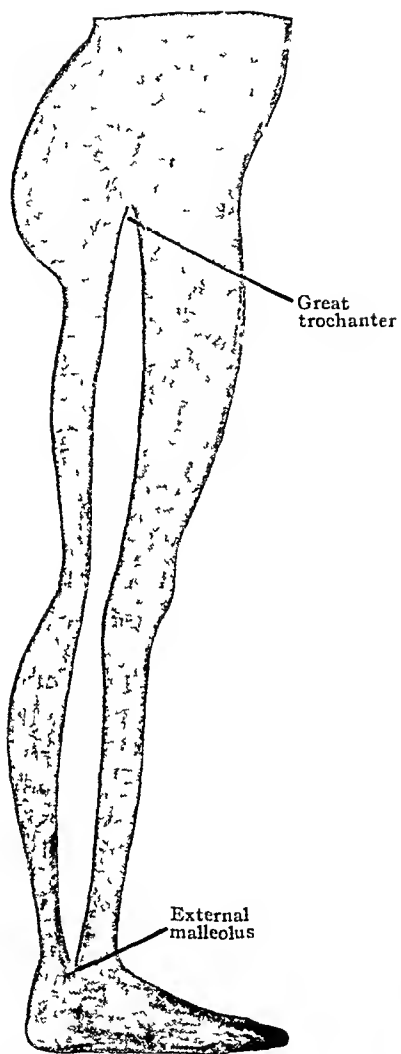


FIG 3 —Showing amount of skin excised from outer aspect of limb

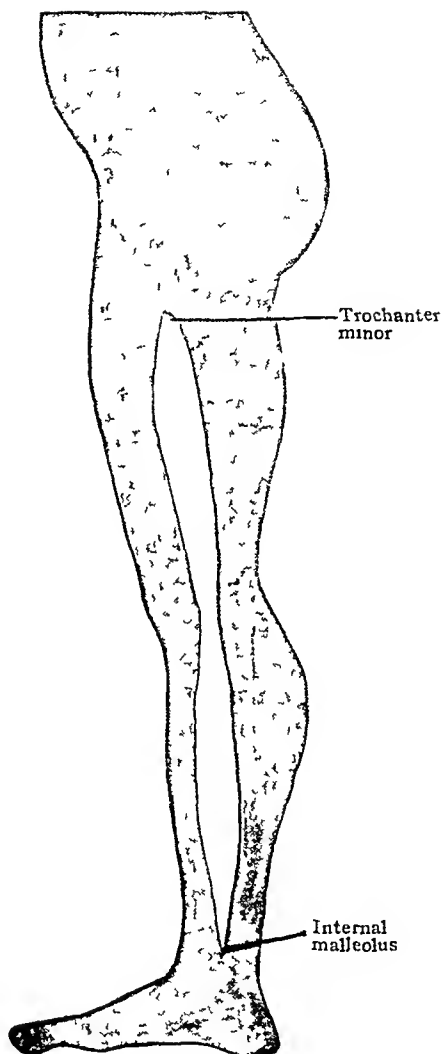


FIG 4 —Showing amount of skin excised from inner aspect of limb

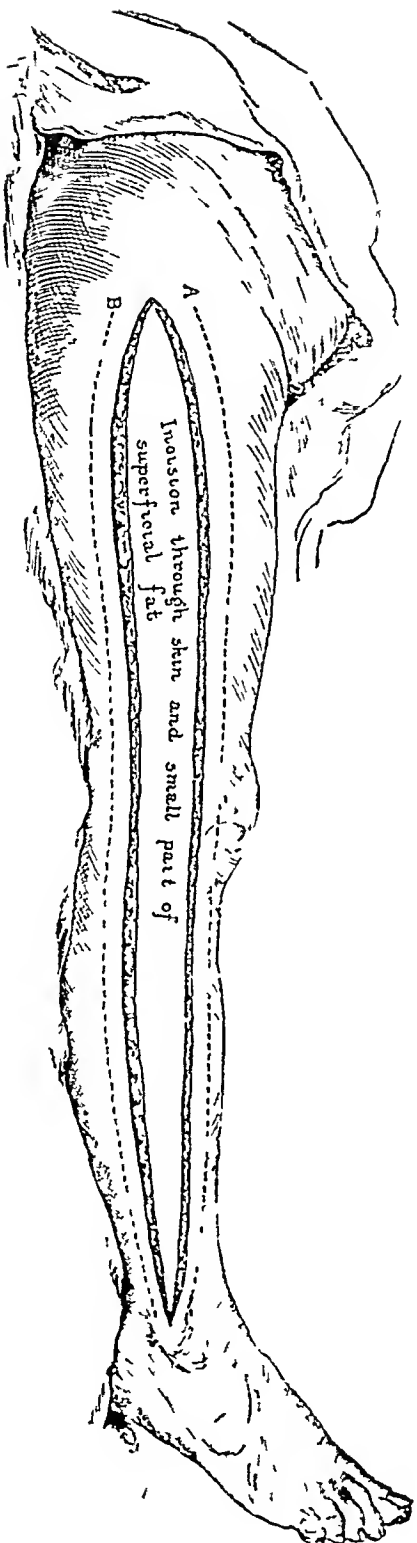


FIG 5.—Incision used on the outer surface of the thigh and leg. Dotted lines *A* and *B* show extent to which the skin is reflected for the removal of subcutaneous fat (Sistrunk). Permission to use this illustration has been obtained from Dr Sistrunk and J A M A

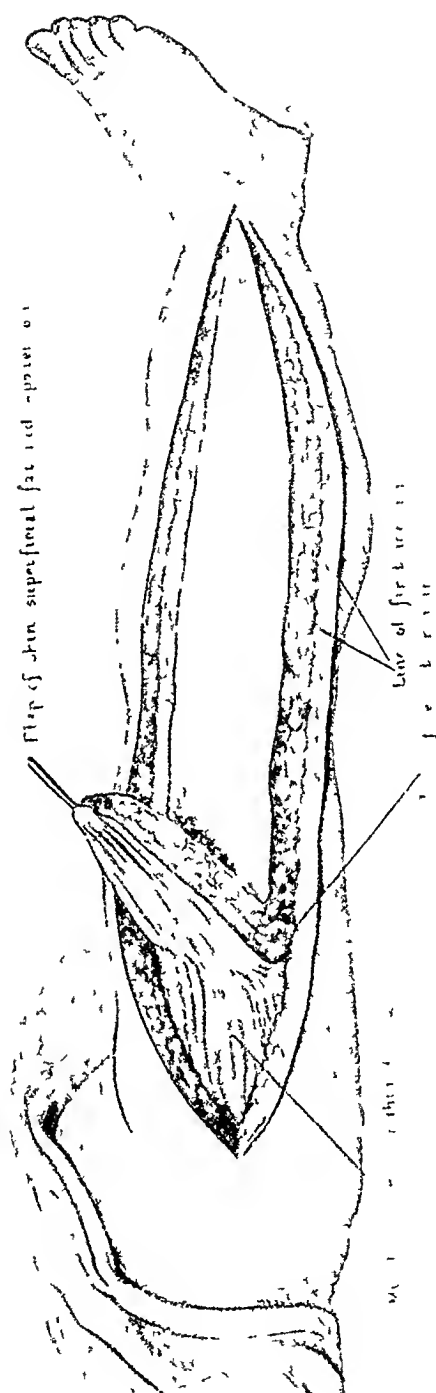


FIG 6 —Skin a large amount of subcutaneous fat and aponeurosis removed in one piece (after Sistrunk) obtained from Dr Sistrunk and J A M A

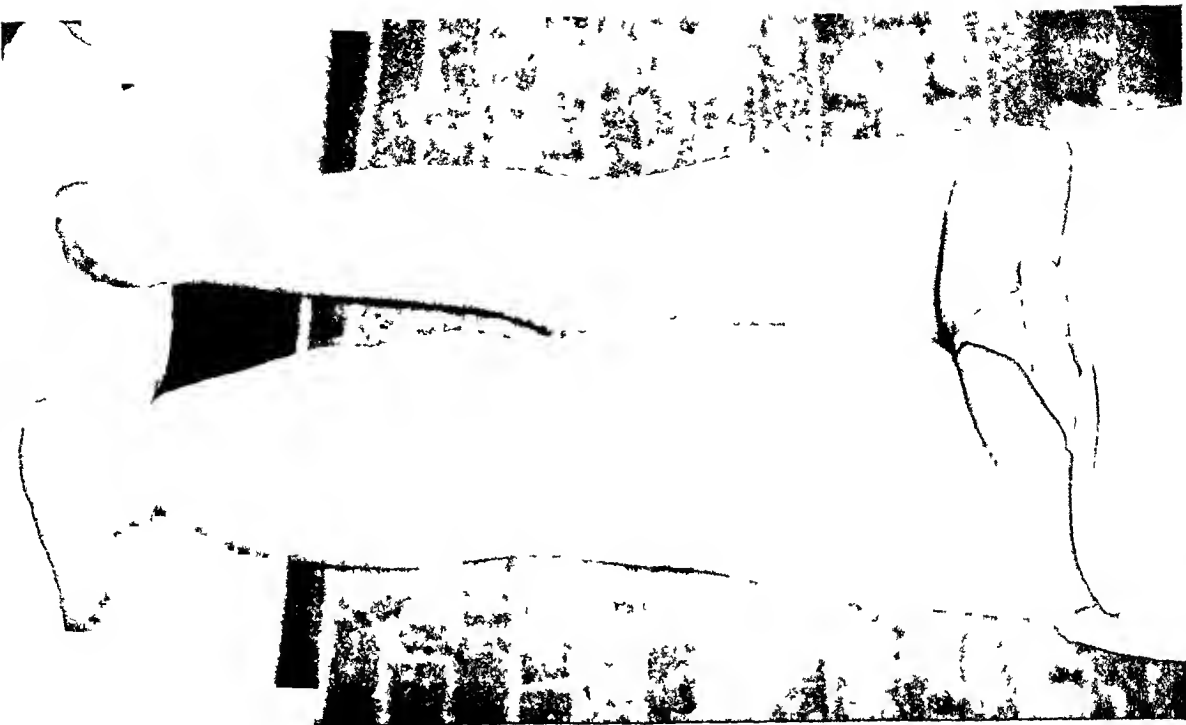


FIG 7 — Before operation



FIG 8 — Before operation



FIG 9 —After operation

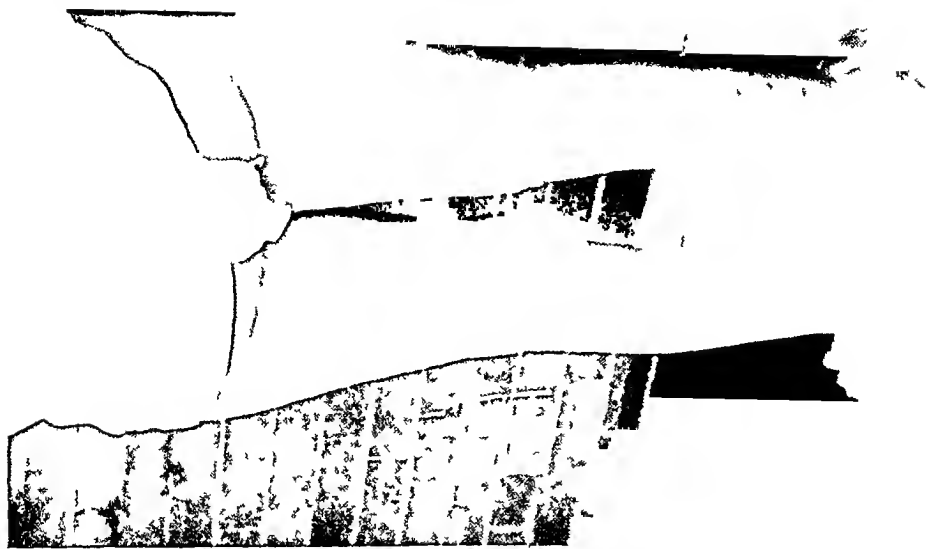


FIG 10 —After operation

ELEPHANTIASIS AND THE KONDOLEON OPERATION

hydrochloric acid, diluted and taken with each meal. For the first three weeks of her convalescence, 10 c.c. doses of antistreptococci serum were administered at three-day intervals. The limb was bandaged daily before arising with an elastic bandage. She was told to continue this for three or four months after operation. She was discharged on August 5, 1919, in good condition (Figs 9 and 10).

The change in the appearance of the limb is astonishing within a week after the operation. In that portion of the limb not reached by the incision the œdema loses its hard brawny feeling at once and resembles that of an ordinary varicose limb, subsiding very rapidly after the first week to a normal aspect, with very little pitting on pressure. There is œdema, of course, when the patient begins to walk about.

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STUDIES IN BONE GROWTH

TRIPLE CALCIUM PHOSPHATE AS A STIMULUS TO OSTEOGENESIS

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In presenting the experimental findings included in this paper, the author wishes to express appreciation of the resources in organization and equipment made possible through the generosity of the Surgeon General who permitted the addition of an animal research annex to the Laboratories at U. S. Army General Hospital No. 3. Such equipment and efficient technical assistance allowed the continuation of investigations in bone growth and allied subjects, from the early days of this hospital's establishment.

These animal experimentations were carried on coincidentally with our clinical bone work at the hospital, with the purpose of supplementing earlier studies,¹ made about ten years ago at the Cornell Animal Hospital, relative to various phases of bone growth. Those earlier experiments included the fusing of the vertebræ of a dog by means of the inlay graft, as well as investigation of the relative osteogenesis of bone secured from different portions of the anatomy of dogs and rabbits. Other experimental findings emphasized the high osteogenetic potency of the periosteum when removed *completely*, which was quite possible if secured by *scraping* with force the outer surface of the bone with a sharp instrument. Studies were also made which bore out the inadvisability of attempting transplantation of bone from one species into another, such as dog's tissue into a sheep, or sheep's bone into a rabbit.

Among our early animal researches at U. S. Army General Hospital No. 3 have been studies in the etiology of pseudarthrosis,² in which attempts were made to produce this condition by use of massive and repeated exposures to the X-ray, by the removal of portions of the shafts of long bones and by various types of splinting. In all of our efforts, however, we were unable to produce a single case of pseudarthrosis, owing to the early and rapid union of the shafts of the long bones. We were able to report, however, that in our experience, no appreciable influence was exerted by the X-ray upon callus formation, there being no difference in

¹ Albee, F. H. "An Experimental Study of Bone Growth and the Spinal Transplant," J. A. M. A., 60, 1044-49, April 5, 1913.

² Albee, F. H., and Morrison, H. F. "Studies in Bone Growth—an Experimental Attempt to Produce Pseudarthrosis," Am. J. Med. Sc., January, 1920.

length of time required for union in those cases given repeated massive X-ray treatment and in their controls

A second purpose of our research work at U S Army General Hospital No 3 was to discover, if possible, a reliable artificial stimulus to bone growth. In the aim of increasing the osteogenetic activity of bone in delayed union or in pseudarthrosis, a great variety of substances have been injected into the site of the lesions, or otherwise introduced into the system. An abstract of recent literature shows that the following materials have been used for this purpose: Osmic acid, fibrin, blood, gelatine and lime salts (calcium chloride), zinc chloride, thyroïdin, glacial acetic acid, iodine tincture, adrenalin, hypophysis extract, bone marrow, copper sulphate, oil of turpentine, ammonia, lactic acid (50 per cent), silver nitrate solution, alcohol, carbolic acid (5 per cent solution), oak bark extract (tannic), vaccines, and sera.

The very number and variety of these methods would indicate that none has proved successful in promoting osteogenesis. The great advantage, however, of such an agent has led one to the search with ever renewed enthusiasm. Early in the history of this hospital, investigations were begun on the value of triple calcium phosphate as a stimulus to bone growth. These studies have been extended over a long period of time, and the authors take pleasure in stating that they believe that an efficient and trustworthy stimulus to osteogenesis has been found in this chemical agent. Due credit should be given to Capt Richard J Behan, M C, U S A, for the verbal suggestion of the agent.

Technic—In all of our research work in bone growth, rabbits were used as experimental subjects, young to middle-aged adults being always chosen. Careful asepsis was invariably observed, the field of operation being treated with a 3½ per cent tincture of iodine preparation. In our earlier studies in pseudarthrosis,² it was usually our method, after fracturing both bones of the foreleg, to apply an external splint for fixation and support. It was later found possible to avoid the necessity of external splinting by fracturing only one of the two bones of the foreleg, relying upon the other bone for fixation and support. We found that the wounds healed successfully when the skin edges were carefully approximated by suture and the line of suture was painted with 3½ per cent tincture of iodine. This method was accordingly followed in all of our experiments with triple calcium phosphate, and it is of interest to report that in this whole series, numbering over 60, together with their controls, there occurred not one instance of infection.

In our investigation of triple calcium phosphate as a stimulus to bone growth, a classification of cases has been made, according to type of operative treatment. In cases of the first type, fragments of bone were first removed completely from the radius, leaving a gap in the shaft. Into this hiatus between the bone ends was then injected 1 cc of 5 per cent solution of triple calcium phosphate. This was prepared by suspension of 5

per cent of triple calcium phosphate in distilled water which was then sterilized for three successive days in the Arnold sterilizer, at 60° C. In the second type of experiment, no bone was removed nor was the radius fractured, but an attempt was made, after exposing the radius, to introduce $\frac{1}{2}$ c c of 5 per cent solution of triple calcium phosphate under the periosteum. The animals in all cases were radiographed frequently, and the clinical progress noted. The procedure in each type of operation is given in detail, as follows:

First Type—After the usual preparation by shaving and iodine technique, an incision was made in the foreleg (usually the right), exposing the radius. A portion of the shaft, about one-quarter inch in length, was then removed with its periosteum intact. The wound was closed with plain catgut No. 1, and after painting the limb with iodine, the animal was returned to its cage without dressing or splint, the other bone serving in the capacity of the latter. Usually on the third day following operation, 1 c c of 5 per cent solution of triple calcium phosphate was injected into the gap between the ends of the bone fragments (see Fig. 1). In a few instances the solution was injected at time of operation, before closing the skin, while in some of our later experiments the injection was made five days after fracture. These various cases will be noted in the report of the detailed experimental findings. In this type of experiment, in order that the controls might be absolutely trustworthy, the radius of the other leg of the same animal was always used, when possible.

Second Type—In the second class of cases, the foreleg was given the same preliminary preparation as in the preceding group and the radius was exposed. The bone was not broken in these cases, but after injuring it to a slight extent by scratching with the point of the needle, an attempt was made to inject $\frac{1}{2}$ c c of 5 per cent solution of triple calcium phosphate beneath the periosteum of the radius with the hypodermic syringe (see Fig. 19). No controls were considered necessary in this type of experiment, as in no instance was there appreciable stimulation of osteogenesis. It is quite probable that in these cases the solution infiltrated the soft parts, and that very little, if any, actually came in contact with the bone tissues.

A detailed report of the following experiments is given:

EXPERIMENT 10—Subject Common hare

March 11, 1919 Operation (first type) on right radius

March 12 1 c c of 5 per cent solution triple calcium phosphate injected into hiatus between ends of bone

Radiographic Findings—March 11 X-ray shows gap of $\frac{1}{4}$ inch, with no free fragments of bone (see Fig. 1)

March 18 The ends of the shaft fragments are already beginning to close in, with some callus formation in the soft parts about the lesion (see Fig. 2)

March 25 Fourteen days after operation. Already there is evidence of union of the fragments, with a large amount of callus formation (see Fig. 3)

April 1 The gap is entirely filled. There is an increased density of callus about the site of the lesion, with more perfect solidification (see Fig. 4)

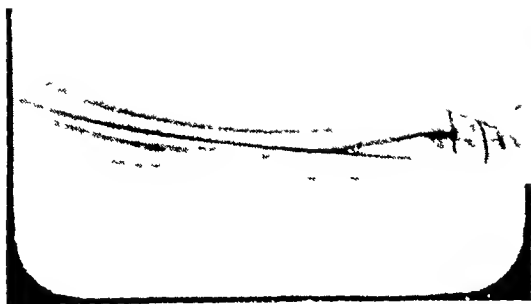


FIG 1—Experiment 10 Day of operation showing gap in shaft of right radius due to removal of about one-quarter inch of bone

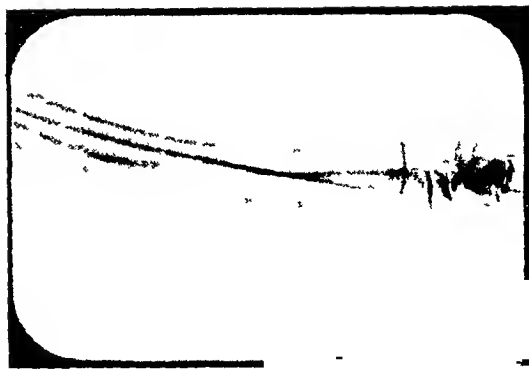


FIG 2—Experiment 10 Seven days after operation Into the hiatus in the shaft was injected one cubic centimetre of five per cent solution triple calcium phosphate six days before this radiograph was taken Note that the ends of the shaft fragments are already beginning to close in There is some callus formation in the soft parts about the lesion



FIG 3—Experiment 10 Fourteen days after operation Union of the radial fragments is evident with a large amount of callus formation



FIG 4—Experiment 10 Twenty-one days after operation Note the increased density of callus formation and the more perfect solidification

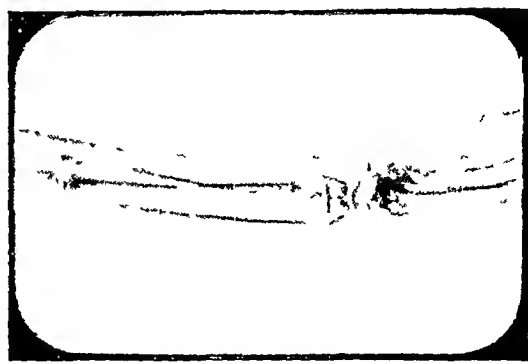


FIG 5—Experiment 10 Thirty one days after operation The exuberant callus is now beginning to flatten and to disappear in the periphery

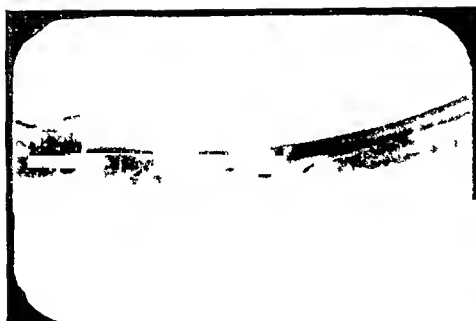


FIG 6—Experiment 10a Control of Experiment 10 Day of operation showing removal of about one quarter inch of bone from shaft of left radius This case was not treated with triple calcium phosphate



FIG 7—Experiment 10a Thirteen days after operation showing no appreciable change Compare with Experiment 10 (Fig 3)

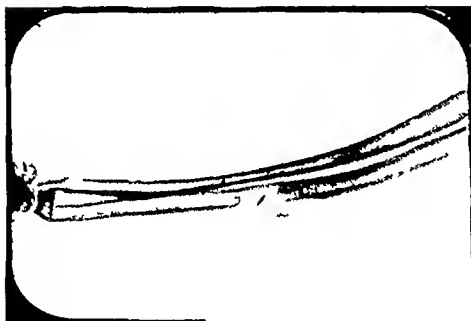


FIG 8—Experiment 10a Thirty one days after operation The space has not yet been bridged and there is very little callus formation Compare with Experiment 10 (Fig 5) in which triple calcium phosphate was used and note the striking contrast in amount of bone proliferation in the two cases at the same length of time after operation

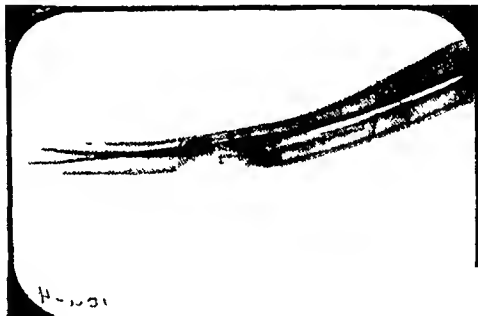


FIG 9—Experiment 10a Forty four days after operation The bone is now united along one side leaving a V shaped defect There is a small amount of callus

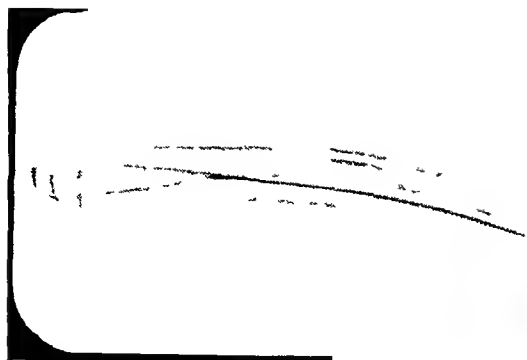


FIG 10 — Experiment 11 Day of operation, showing gap in shaft of right radius. On the day following operation, one cubic centimetre of five per cent solution triple calcium phosphate was injected into this hiatus

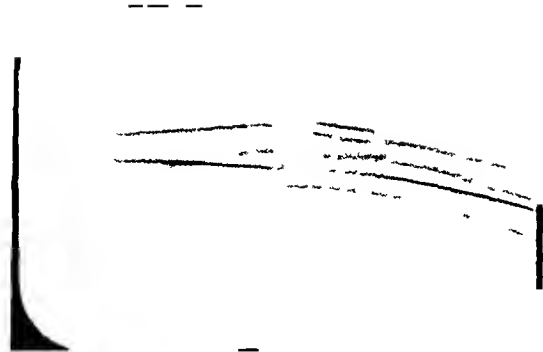


FIG 11 — Experiment 11 Seven days after operation. There is evidence of some callus formation, and the distance between the ends of the fragments seems slightly decreased

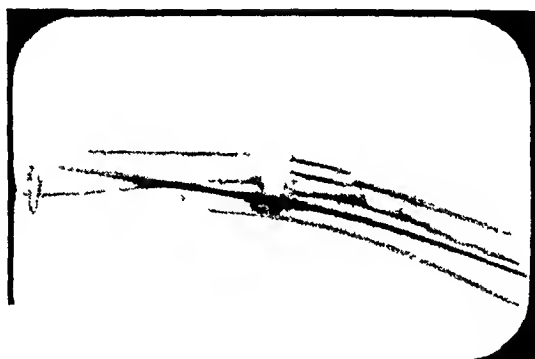


FIG 12 — Experiment 11 Fourteen days after operation. Already union of the shaft fragments is evident with marked formation of callus producing a plumber's 'wiped joint'



FIG 13 — Experiment 11 Twenty-one days after operation, showing the hiatus completely filled. There is solid union of the fragments with a large amount of well formed callus

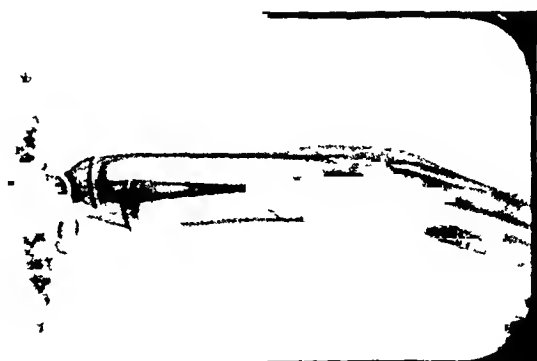


FIG 14 — Experiment 11 Thirty-one days after operation. Much of the excess callus has now disappeared, the bone is beginning to shape itself



FIG 15 —Experiment 11a Control of Experiment 11 Day after operation showing hiatus in shaft of left radius This case was not treated with triple calcium phosphate



FIG 16 —Experiment 11a Twenty nine days after operation The gap is now about one third closed with no excess callus formed

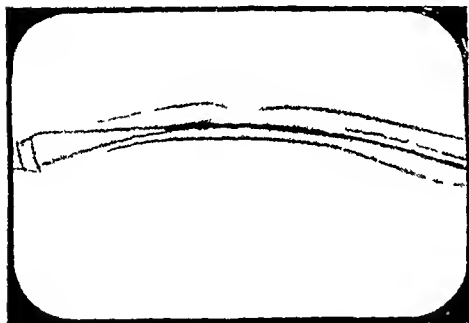


FIG 17 —Experiment 11a Thirty-seven days after operation The hiatus is nearly closed Callus formation is meagre



FIG 18 —Experiment 11a Forty-nine days after operation Union of the fragments is now complete

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April 11 Thirty-one days after operation The exuberant callus is beginning to flatten and to disappear in the periphery (see Fig 5)

EXPERIMENT 10a—Control of Experiment 10

March 17, 1919 Operation on left radius—fragment of bone removed as in No 10 This case was not treated with triple calcium phosphate

Radiographic Findings—March 17 Day of operation, showing gap in shaft (see Fig 6)

March 30 Thirteen days after operation There is no appreciable change, as shown in Fig 7 Compare with Experiment 10 (Fig 3)

April 17 Thirty-one days after operation (see Fig 8) The X-ray shows that the space has not been bridged, there is very little callus formation Compare with Experiment 10 at the same length of time after operation (see Fig 5)

April 29 Forty-four days after operation The bone is now united along one side, leaving a V-shaped defect There is a small amount of callus (see Fig 9) Note the striking contrast between this case and Experiment 10 (in which triple calcium phosphate was used) in the amount and rapidity of bone proliferation

EXPERIMENT 11—Subject Common hare

March 11, 1919 Operation (first type) on right radius

March 12 1 cc of 5 per cent solution triple calcium phosphate injected into gap between ends of bone

Radiographic Findings—March 11 The X-ray shows gap of $\frac{1}{4}$ inch in right radius, with no free fragments present (see Fig 10)

March 18 A small amount of callus formation is noted The distance between ends of bone seems slightly decreased (see Fig 11)

March 25 Fourteen days after operation Marked formation of callus is noted, producing a plumber's "wiped joint," extending from both distal and proximal fragments, with evidence of union of the fragments (see Fig 12)

April 1 Twenty-one days after operation The gap is now completely filled and there is solid union of the fragments, with a large amount of well-formed callus (see Fig 13)

April 11 Thirty-one days after operation Much of the excess callus has disappeared, the bone is beginning to shape itself (see Fig 14)

EXPERIMENT 11a—Control of Experiment 11

March 17, 1919 Operation on left radius—fragment of bone removed, as in No 11

Radiographic Findings—March 18 Day after operation, showing gap in shaft (see Fig 15)

April 15 The space is about one-third closed, with no excess callus formed (see Fig 16)

April 23 The hiatus is almost closed, with very little callus formed (see Fig 17)

May 5 Forty-nine days after operation Union is complete (see Fig 18)

EXPERIMENT 12—Subject Belgian hare

March 20, 1919 Operation (first type) on right radius

March 23 One cc of 5 per cent solution triple calcium phosphate injected into the defect in shaft

Radiographic Findings—March 21 X-ray shows gap of $\frac{1}{8}$ to $\frac{1}{4}$ inch There are no free fragments between ends of the bone

March 28 There is no change in appearance

April 4 There is very little change noted

April 14 Union is almost complete

April 23 There is solid union

EXPERIMENT 12a—Control of Experiment 12

April 23, 1919 Operation on left radius Fragment of bone removed as in No 12

Radiographic Findings—April 24 X-ray shows gap of $\frac{1}{4}$ inch in left radius, with no free fragments

April 30 No changes are noted

May 8 There is very little change in appearance of radiogram

May 16 A small amount of callus formation is noted

May 21 There is partial union

May 27 There is solid union

EXPERIMENT 13—Subject White buck

March 20, 1919 Operation (first type) on right radius

March 23 One c c of 5 per cent solution triple calcium phosphate injected into gap in shaft of radius

Radiographic Findings—March 21 X-ray shows gap of $\frac{1}{4}$ inch in right radius

April 4 Partial closure of space is noted, with but meagre callus formation

April 21 There is solid union, and good alignment, with no excessive formation of callus

EXPERIMENT 13a—Control of Experiment 13

April 23, 1919 Operation on left radius Fragment of bone removed as in No 13

Radiographic Findings—April 24 X-ray shows a gap of $\frac{1}{4}$ inch, with no free fragments

May 10 No changes are noted until May 10th, when the X-ray shows formation of callus, but not in excessive amounts

May 20 There is solid union, but with no excess of callus

EXPERIMENT 14—Subject Common hare

April 3, 1919 Operation (first type) on left radius At time of operation, 1 c c of 5 per cent solution triple calcium phosphate was introduced into the bony defect, and wound was then closed

Radiographic Findings—April 4 X-ray shows a bony defect of $\frac{1}{8}$ inch in the left radius A few free fragments of bone are present

April 12 Very little change is noted

April 18 Fifteen days after operation, showing evidence of union of the ends of the bone along one border Compare with Cases 10 and 11, in which union was evident fourteen days after operation (see Figs 3 and 12) The presence of a few free fragments of bone, as noted above, should also be borne in mind

April 30 The gap is completely filled, except for a V-shaped space on one border Very little callus is noted

EXPERIMENT 14a—Control of Experiment 14

February 13, 1919 Operation on right radius Fragment of bone removed, as in Experiment 14

Radiographic Findings—February 13 X-ray shows defect of $\frac{1}{4}$ inch in right radius

February 23 No change is noted

March 8 The gap is about two-thirds closed, with very little proliferation of bone

March 25 There is solid union The outlines of the bone are very nearly normal

EXPERIMENT 15—Subject Common hare

April 3, 1919 Operation (first type) on right radius At time of operation 1 c c of 5 per cent solution triple calcium phosphate was introduced into gap between the ends of the bone fragments, the wound was then closed

Radiographic Findings—April 4 X-ray shows a V-shaped defect of right radius, $\frac{1}{4}$ inch across, at the open side A few free fragments are present

April 12 No change is noted

April 18 The defect has closed in from each end to about one-fourth of its original extent

April 30 Twenty-seven days after operation the defect is entirely filled, save for a slight depression on the surface of the bone Callus formation is very meagre

May 6 The defect is completely closed

EXPERIMENT 15a—Control of Experiment 15

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February 17, 1919 Operation on left radius Fragment of bone removed as in Experiment 15

Radiographic Findings—February 17 X-ray shows a defect of $\frac{1}{4}$ inch in the left radius, with two small free fragments present

February 28 Slight proliferation of bone from proximal and distal fragments is noted

March 7 Eighteen days after operation New bone bridges the gap, leaving a defect on the outer surface of the radius The presence of free fragments of bone, originally left in the hiatus, may have a significant bearing on the rapid union in this case

March 17 Union is complete, with no excess callus

EXPERIMENTS 16 to 25, inc, which were of the second type, follow Experiment 30 given below

EXPERIMENT 26^a—Subject Common hare

June 16, 1919 Operation (first type) on right radius

June 21 Injection of 1 cc of 5 per cent solution triple calcium phosphate between the gap in the shaft fragments

Radiographic Findings—June 21, The X-ray shows a bony defect of $\frac{1}{4}$ inch in the right radius, with no free fragments

July 5 Fourteen days after injection of triple calcium phosphate, good union is noted, with strong callus formation about the ends of the bone (Compare with Cases 10 and 11)

EXPERIMENT 27—Subject Common hare

June 16, 1919 Operation (first type) on right radius

June 21 One cc of 5 per cent solution triple calcium phosphate injected into gap between the ends of the shaft fragments

Radiographic Findings—June 21 X-ray shows a bony defect of $\frac{1}{4}$ inch in right radius, with one small free fragment

July 5 The defect is almost closed, with meagre callus formation

July 10 Nineteen days after injection of triple calcium phosphate there is complete union, with little or no excess callus formed

EXPERIMENT 28—Subject Common hare

June 16, 1919 Operation (first type) on right radius

June 21 Injection of 1 cc of 5 per cent solution triple calcium phosphate in hiatus between shaft fragments

Radiographic Findings—June 21 X-ray shows absence of $\frac{1}{4}$ inch of bone from right radius, with no free fragments present

July 5 Fourteen days after injection of triple calcium phosphate, the defect has been bridged by new bone About the end of the proximal fragment callus has formed, there is no evidence of callus about the distal portion

EXPERIMENT 29—Subject Common hare

June 16, 1919 Operation (first type) on right radius

June 21 One cc of 5 per cent solution triple calcium phosphate injected into gap between ends of bone

Radiographic Findings—June 21 The X-ray shows a loss of $\frac{1}{4}$ inch of substance from right radius A few free fragments are noted

July 5 Fourteen days after injection of triple calcium phosphate, the defect is bridged by new bone, but the hiatus is not completely filled There is no excess of callus formation

July 12 The gap is completely filled and there is solid union Note, also, in this case that a few free fragments of bone were originally left in the hiatus between the ends of the shaft fragments

EXPERIMENT 30—Subject Common hare

^a Experiments 26 to 30, inclusive, have no controls

June 16, 1919 Operation (first type) on right radius

June 21 Injection of 1 cc of 5 per cent solution triple calcium phosphate into gap between ends of bone

Radiographic Findings—June 21 The X-ray shows a loss of $\frac{1}{4}$ inch of substance from right radius, with no free fragments present

July 5 The defect is almost closed, with a large amount of callus formed on the adjacent surface of the ulna

July 14 Twenty-three days after injection of triple calcium phosphate, there is solid union, with a moderate amount of callus

EXPERIMENTS 16 to 25, inclusive (Second Type)—These experiments were all of the second type, the first five being done on one litter of rabbits of adult age, using the right radius, the last five being performed likewise on animals of one litter, the left radius being used in these latter instances

Cases 16 to 20, inclusive, were injected with $\frac{1}{2}$ cc of 5 per cent solution triple calcium phosphate on May 6, 1919 Radiographs taken as late as June 12th (thirty-seven days after operation), failed to show the slightest formation of callus, or of new bone Illustrative of experiments of this group is Case 17 It was possible to observe this case forty-four days after operation, at which time radiographic findings were negative (see Figs 19 to 22)

Cases 21 to 25, inclusive, were injected on May 12, 1919 Radiographs taken thirty-one days after operation, on June 12th, were negative

CONCLUSIONS

1 Cases of fracture, with loss of substance, showed a much more rapid bone growth and union when triple calcium phosphate was injected into the gap between the bone ends than did the controls without its use

Of the cases treated with this agent, especially remarkable bone formation is shown in Experiments 10 and 11 (see Figs 1 to 5 and 10 to 14)

2 Callus formation in the cases of fracture treated with triple calcium phosphate extended far into the soft parts, apparently following the penetration of the solution (see Figs 3, 4, 5, 12 and 13) In some cases, the callus even extended out beneath the skin

3 For our entire series of experiments, the average length of time for union in cases of fracture treated with triple calcium phosphate was thirty-one days

The average length of time for union in the controls was forty-two days

In our total series, therefore, cases of fracture treated with triple calcium phosphate showed union at least eleven days earlier than did the controls, in other words, union in cases stimulated by this agent occurred in 73.81 per cent of the time which seemed to be required in the controls For the smaller number of experiments, herewith reported in detail, even more striking relationships may be observed The average number of days elapsing between date of injection of triple calcium phosphate and the first radiographic evidence of union in these experiments⁴ was 19

⁴ In rare instances, it was found by early radiographic examination that one or more free fragments of bone were present in the hiatus between the ends of the shaft In such cases, already noted in the foregoing detailed reports, an added influence on rapidity of bone growth may have been exerted by these loose fragments

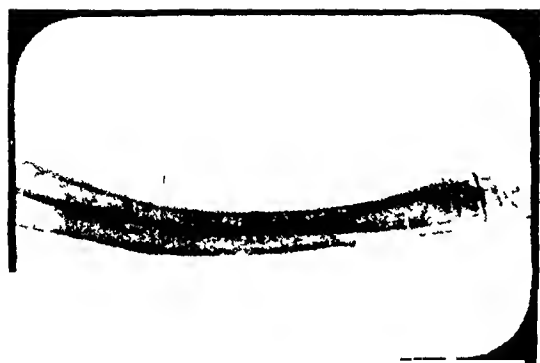


FIG 19 —Experiment 17 Ten days after operation of the second type In this case no bone was fractured, but an attempt was made to inject one-half cubic centimetre of five per cent solution triple calcium phosphate subcutaneously beneath the periosteum of the right radius Note that no shadow is cast by the solution

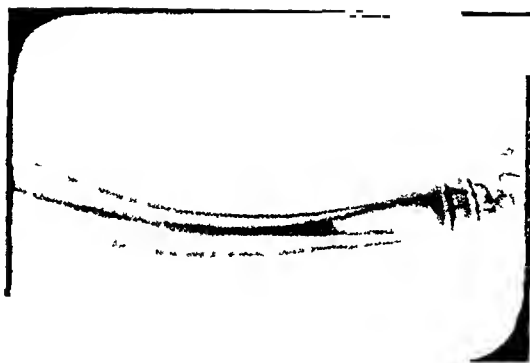


FIG 20 —Experiment 17 Showing case twenty-four days after injection of triple calcium phosphate There is no change apparent

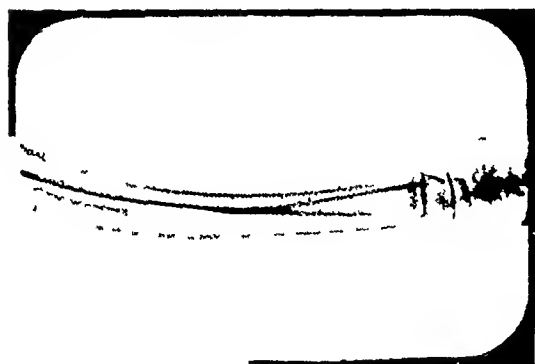


FIG 21 —Experiment 17 Thirty seven days after injection of the solution The radius remains unchanged

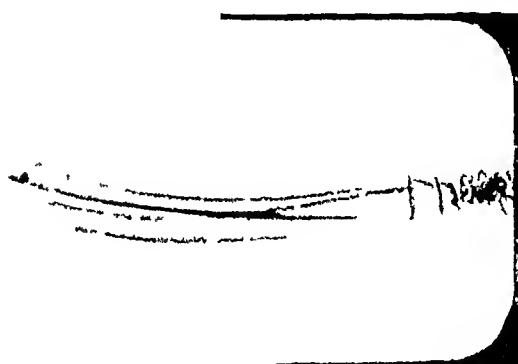


FIG 22 —Experiment 17 Forty-four days after injection of triple calcium phosphate Note that in this case there has been no apparent stimulation of bone growth even to the slightest degree

Furthermore, of these cases, over 50 per cent showed union by the fifteenth day after injection of the agent

In computing the length of time required for union to take place, some error may arise owing to the impossibility of determining the precise time at which union of the fragments occurred. With due allowance for error, however, the decided advantage in favor of the cases treated with triple calcium phosphate is evident

4 No appreciable bone growth was stimulated by an attempt to inject triple calcium phosphate beneath the periosteum of the radius in cases of the second type, in which the bone was not fractured. Undoubtedly the solution in such cases infiltrated the soft parts overlying the periosteum and did not actually come into contact with the bone-growing tissues

It is evident that osteogenesis was stimulated by triple calcium phosphate in conjunction with fracture, or, in other words, with trauma of sufficiently great severity to open up those bone surfaces containing active bone-growing cells, namely, the periosteum, compact bone, endosteum and marrow, thereby allowing the intimate contact of the solution with these tissue layers

5 It was demonstrated in the early portion of those experiments in which an attempt was made to inject triple calcium phosphate subcutaneously beneath the periosteum, that the solution itself did not produce an X-ray shadow, since all the radiographs were entirely negative, thus ruling out any possible error in this respect (see Fig 19)

Moreover, callus formation in all our series of cases treated with triple calcium phosphate seemed in no degree inhibited by frequent exposures to the X-ray. This had already been clearly demonstrated in our earlier studies in pseudarthrosis²

6 No toxic symptoms were noted in any of the cases treated with triple calcium phosphate. At no time did this agent act as an irritant locally

7 In our animal experimentations, only one injection of triple calcium phosphate was administered in each case treated. We would offer the suggestion that the stimulating action of this agent might be increased by *repeated* injections at frequent intervals in unfavorable clinical cases of pseudarthrosis, whether or not preceded by a bone graft operation

8 It is believed that these findings with triple calcium phosphate are of sufficient value to warrant their clinical application. We wish to state that this agent is now being tried upon human subjects, and a report of these results will be subsequently presented

A STUDY OF THE CAUSES OF DELAYED UNION AND NON-UNION IN FRACTURES OF THE LONG BONES*

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STIMULATED by the observation of Dr Joseph A Blake¹—that the suspension-traction treatment as used by him in gunshot fractures leads to more rapid union, especially in uninfected comminuted fractures—a review of fractures of the long bones treated in our clinic at St Luke's Hospital, Bethlehem, Pa, from September 1, 1915, to January 1, 1919, has been undertaken, primarily to ascertain any clinical factors that may bear upon the question of union, and incidentally to investigate the effect of former methods of treatment upon comminuted fractures

General Considerations—A fractured bone may unite in what may be considered normal time, the time for union may be greatly increased, or complete bony union may never occur We have, therefore, from the point of time 1 Normal union 2 Delayed union 3 Non-union

Delayed union and non-union may be due to

I *General Causes*—1 Nervous diseases, such as tabes dorsalis, and general paresis 2 Constitutional disorders, such as gout, diabetes, osteomalacia, chronic nephritis 3 General infections (a) Erysipelas and acute exanthemata, measles, scarlet fever, typhoid fever, etc (b) Syphilis 4 Old age 5 Starvation, insufficient nutrition, scurvy 6 Anæmia (a) Severe hemorrhage (b) Pernicious anæmia (c) Grave secondary anæmia

II *Local Causes*—1 Mechanical interference with fracture union (a) Separation and displacement of the fragments (b) Interposition of soft tissues between the fragments (c) Incomplete immobilization after reduction of fracture

2 Deficient blood supply (a) Injuries to the nutrient artery of the affected bone (b) Severe trauma to soft tissue adjacent to fracture (c) Severe trauma to bone and periosteum, causing a partial or complete loss of continuity

3 Bone lesions (a) Osteomyelitis-necrosis (b) Tumors—primary or secondary—in which pathological fractures have occurred

4 Infection of the soft tissues

5 Nerve injury

III *Treatment of the Fracture Itself*

The following observations are based upon records of 374 fractures of the humerus, radius and ulna, femur, tibia and fibula It is the purpose of this study to peruse the records submitted—to ascertain

* Read before the Association of Resident and Ex-Resident Physicians of the Mayo Clinic, October 8, 1919

CAUSES OF DELAYED UNION AND NON-UNION

the relative frequency with which delayed union and non-union have been found, and to analyze these findings, to determine what especial factors play a part in the prevention of proper recovery in fractures. It is obvious, however, that, in many instances, the decision will be complicated by evidence indicating that, in a given case, there is far more than a single criminal at whom an accusing finger may be pointed.

To determine whether delayed union had occurred or not, a tabulation of the time of union of the uncomplicated fractures for each location was made. The majority were found to fall between certain limits. All fractures found to require approximately eight days more for union than the upper normal limit were regarded as showing delayed union. For instance, in fractures of the lower third of the tibia, union was estimated as occurring normally in from thirty to forty-two days, all fractures requiring fifty days or more were considered to exhibit delayed union. Union must not be confused with consolidation. Union was considered in this paper to occur when no vestige of abnormal mobility could be detected at the seat of fracture, and had no relation to the strength of the repair. If, after six or more months, the repair of the bone had reached a standstill, and abnormal mobility still persisted, non-union was believed to have occurred.

LOCATION

			Delayed union	Non-union
Humerus, 50	Upper end	15		
	Shaft	27		
	Upper 3d	10		
	Middle 3d	12	2 (16⅔%)	1 (8⅓%)
	Lower 3d	5		
	Lower end	8		
	Delayed union	4%		
	Non-union	2%		
Radius and ulna, 67	Upper end	6		
	Head of radius	1		
	Olecranon	5	1	
	Shaft	45		
	Upper 3d	8	1 (12½%)	1 (12½%)
	Middle 3d	9	3 (33%)	
	Lower 3d	28	7 (25%)	
	Lower end	16		
	Delayed union	18%		
	Non-union	14%		
Femur, 81	Upper end	23		
	Neck	15	1 (6⅔%)	4 (26%)
	Trochanteric	8		
	Shaft	55		
	Upper 3d	13	2 (15%)	

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			Delayed union	Non union
Femur	Shaft, Middle 3d	30	7 (23%)	
	Lower 3d	12	5 (41½%)	
	Lower end (condylar)	3		
	Delayed union	18 5%		
	Non-union	5%		
Tibia, 140	Upper end (condylar)	1		
	Shaft	119		
	Upper 3d	24	13 (54%)	1 (4%)
	Middle 3d	43	12 (30%)	1 (2%)
	Lower 3d	52	10 (20%)	2 (4%)
	Lower end	20		
	Delayed union	25%		
	Non-union	28 5%		

Fibula, alone, 38 No cases of delayed union, and no cases of non-union

SUMMARY

Humerus Delayed union and non-union seem fairly confined to the middle third

Radius and ulna Delayed union is more prone to occur in the distal half

Ulna Non-union occurs more frequently in the upper third

Femur Non-union is more likely to occur in the neck In the shaft, the distal third seems more liable to suffer delay in union

Tibia Delayed union and non-union seem fairly equally distributed over the entire shaft, with a greater tendency to delayed union in the upper third, and to non-union in both upper and lower thirds

DISCUSSION

The middle third of the humerus and the neck of the femur are quite generally recognized as localities where delayed and non-union are likely Stimson² believed "delayed union occurred more frequently in the upper limbs" Jones,³ in referring to shaft fractures, mentions the juncture of the middle and upper thirds of the humerus, the middle of the femur, and the lower third of the tibia and fibula as the most common sites of delayed union Our statistics seem to approximate fairly closely Jones' findings, and show a greater percentage in the lower extremities, especially in the tibia Blake⁴ has observed in war fractures that repair in the tibia is more indolent than elsewhere in the body, and ascribes it to the lack of soft parts over the bone

The fractures of the neck of the femur deserve a somewhat detailed consideration The cases have been difficult to trace, 4 resulted in non-union, 1 in delayed union, 2 died In 3 others, the result cannot be definitely stated Of the 4 cases of non-union, all were intra-capsular, 3 were over seventy-five years of age, and 1 between fifty and sixty The treatment consisted in the application of a plaster cast in extreme abduction as advocated by Whitman, with preliminary manipulation for reduction in unimpacted cases, or simple suspension in abduction by a Hodgen splint Cotton's method of impaction was not used Deficient blood supply of the proximal fragment, and the cancellous character of the part of the bone in-

CAUSES OF DELAYED UNION AND NON-UNION

volved, have been assigned as reasons for non- and delayed union Doctor Henderson,^{5, 6} of the Mayo Clinic, in the last year or two has done much to improve operative technic for the cure of non-union in this group of cases, and has suggested that their great incidence may be due to the lack of proper primary treatment of the fresh fracture

ANALYSIS OF THE CAUSES OF DELAYED UNION

In the 64 cases of delayed union, the cause of delay has been ascribed to

1	Comminution	6
2	Compound fracture	34
	<i>a</i> Simple	4
	<i>b</i> Compound fracture and comminution	15
	<i>c</i> Compound fracture with comminution and infection of the soft tissues	3
	<i>d</i> Compound fracture, with comminution and osteomyelitis	12
3	Plating alone	6
4	Late open reduction	3
5	Mal-union from incomplete reduction	4
6	Undetermined	9
7	Plating for comminuted fracture—infection	1
8	Multiple fractures	1

NOTE—Syphilis existed in 3 cases

It will be noted that local causes which have to do with deficient blood supply, bone lesions or infection, account for the majority of these delayed union cases. A certain number show delay as the result of the treatment of the fracture itself, and, in addition, it will be observed that none of the ascribed "General Causes" figure in this analysis, except syphilis. In 15 cases, during treatment, acute exanthemata occurred (which included typhoid fever, measles, pneumonia, and diphtheria), as well as erysipelas, acute follicular tonsillitis and two cases of delirium tremens. In none of these was there any delay in union. (There were besides two cases that died of uræmia, one of diabetes, and one of septicæmia.)

Three cases of compound, comminuted fracture of the tibia were found to be syphilitic. No manifestations of the disease were apparent, and infection was not definitely admitted, but the Wassermann taken on suspicion, was 4——. Specific treatment seemed, in two cases, to hasten definitely the bony union. The third case developed a severe staphylococcus aureus infection of the leg, after five months of persistent non-union. He finally required amputation. There was no gummatous formation nor did the wound present the appearance of syphilitic ulceration in any of these three cases. But no examination for spirochætes was made directly from the wound. It would therefore seem advisable in all cases of delayed union—even in the absence of history or definite indications of syphilis—to have a routine Wassermann done.

Though it is well known that in the later years of life the time of union is likely to be increased over normal, in our series age seems to have had very little influence, as the following tabulation demonstrates

Delayed union under ten years, 1, ten to twenty years, 10, twenty to thirty years, 14, thirty to forty years, 17, forty to fifty years, 13, fifty to sixty years, 5, sixty years, 4, which corresponds to the age incidence of the fracture itself

DISCUSSION

For purposes of discussion the classification of delayed union falls into the following groups 1 Communion 2 Compound fractures 3 Plating 4 The undetermined type

NOTE—Two of the cases of delayed union had extensive injury of the soft parts, another occurred in a man of sixty-four

I *Communion*—Simple communion occurred in 22 cases Of these Time of union shortened, 1 Time of union normal, 15 Time of union delayed, 6

Most of these fractures were reduced by manipulation under ether—or open operation—and immobilized in a plaster-of-Paris cast Under this treatment, rapidity of union in simple, comminuted, civil fractures would seem the rare exception There is a tendency, rather, to delayed union, though this depends somewhat upon the age of the patient, the extent of the communion, and the trauma

II *Compound Fractures*—There were 52 compound fractures with complete records in this entire series Of these, 34 showed delayed union, and 5 non-union, divided as follows

1 Uncomplicated		13
a Normal union	9 (70%)	
b Delayed union	4 (30%)	
2 Comminuted fractures		39
a Normal union	4 (10%)	
b Delayed union	30 (77%)	
c Non-union	5 (13%)	

NOTE—Osteomyelitis resulted in twelve of the thirty cases of compound comminuted fractures which showed delayed union, and in all five cases of non-union

These figures bear out what is very commonly understood, *ie*, that an open wound with fresh fracture, indicating more or less laceration of the soft tissues, evidently exerts a marked tendency to delayed union—3 out of every 10 cases—(30 per cent) When accompanied by communion, which usually implies an extensive trauma or crush, delay union will occur in three out of every four cases, and non-union in one out of every eight

Osteomyelitis, it is evident, plays a major rôle in the prolongation of the normal time of union It is rarely acute but usually a local chronic form resulting from necrosis of one or more fragments of bone which have become non-viable and act as sequestra or foreign bodies, with the resultant bone cavity and sinus formation, quite similar to what has been designated by Chutro⁷ in War Fractures, "Bone Fistulæ" These fragments, if small, may be extruded through the sinus, but usually require

operative removal In addition, until these cavities have been sometime closed, measures such as bone-grafting cannot be considered for improvement of the type of union

III *Plating*—Plating was assigned as a cause for delayed union in six cases of simple fracture The following table may be of interest

Simple fractures—25 plated	Normal union	Delayed union	Non-union
Humerus	3	0	0
Radius and ulna	6	0	0
Femur	6	2	0
Tibia	3	4	0

These cases are comparatively few and deductions from a few figures are likely to be misleading It is to be noted that all the cases of delayed union occurred in the lower extremity, and in the tibia, in fully fifty per cent A factor that must be considered, however, is that in three of the tibia and one of the femur cases, previous attempts at non-operative reduction had been made, and open operation undertaken only when these had failed—as late as the third and fourth week after injury It is well recognized that to disturb bone repair at this time will delay union It would therefore seem that plating in itself is accountable for delayed union in relatively few cases of simple fracture—possibly 8 per cent of the cases in which it has been used

IV *The Undetermined Type*—This group includes those cases in which delayed union occurred for no obvious reason Jones⁸ has described a type of fracture in the tibia of young children which he considered most refractory There are also cases he mentions that apparently for several weeks show no sign of callus formation or evidence of bony repair in spite of accurate reduction Then suddenly the dormant reparatory processes are awakened, and union will occur fairly rapidly We have not observed any of the cases of the first type, but there has been an occasional case in which no sign of repair can be detected in the usual normal period required for union, and which eventually unites effectually With the idea that there may be in these cases a disturbance of calcium metabolism, or insufficient calcium in the blood, calcium lactate has been administered in one or two instances, with, however, no appreciable effect A study of metabolism in fractures might serve to throw some light upon this obscure group, and result in the elaboration of some satisfactory therapeutics A routine Wassermann might also throw some light upon the etiology of this special class

Late open reduction, as a cause for delayed union, may be explained away by the fact that non-operative methods of reduction were first attempted and open reduction decided upon late in the treatment In any analysis of statistics with regard to delayed union, this group of cases will always figure The evolution of a standardized treatment of fractures, designating more accurately those fractures which should receive early operation, will tend to reduce them to a minimum

Multiple fractures and comminution with infection scarcely merit any consideration further than mere mention

The cases of mal-union from incomplete reduction were all cases that had been treated inefficiently elsewhere, and referred to us after unsuccessful attempts at proper reduction had been made

CAUSE OF NON-UNION

Non-union occurred in ten cases as follows (a) Compound fracture with comminution and osteomyelitis, 5 (b) Fracture of the upper third of the ulna, 1 (c) Fracture of the neck of the femur, 4

These have been discussed elsewhere "Non-union would rarely occur if delayed union received proper attention" Jones⁸

SUMMARY

Among the general causes of delayed and non-union, attention has been called to the fact that syphilis, even in the absence of history and manifestations of the disease, may be a factor in preventing normal union. A routine Wassermann would seem indicated in all cases in which delayed union might be suspected

It will be noted that 50 per cent of the delayed union cases, as analyzed, are due to compound or compound comminuted fractures, and a small number are found caused by comminution alone. Purposely, no fracture treated by balanced suspension and traction has been included in this study

However, it is well known that Blake's treatment in war fractures, which these compound comminuted fractures of civil life so closely resemble, tends to produce more rapid union and return of function. It is gratifying to realize that, as the problem presents itself, there is at hand a method which should obtain improved statistics for this large recalcitrant group. Too, the small number of delayed union cases in which plating is indicated may be diminished by the increased frequency with which balanced suspension will be found applicable

Attention has been called to a group of cases in which the cause for delayed union cannot be accurately determined, and it has been suggested that studies in metabolism may serve to explain the delay and suggest a rational therapeutics

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THE TREATMENT OF BONE CAVITIES⁺

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It has been long recognized that cavities and tunnels in bone, when opening on the surface of the body, heal slowly or not at all

Such cavities result from opening circumscribed pyogenic abscesses in long bones, from removal of local tuberculous foci, from curetting away new growths, from excision of bone cysts and in chronic hæmatogenous osteomyelitis In infected compound fractures, especially gunshot fractures, very complicated cavities and tunnels result The external or subperiosteal callus encloses one or more detached necrotic fragments or sequestra, and this casing of new bone is analogous to the involucrum of chronic hæmatogenous osteomyelitis

It is well known that cavities in the soft parts heal by the gradual approximation of the walls, granulating surface coming in contact with granulating surface and uniting.

In the process of healing in a bone cavity, for example, in the end of the tibia, granulations form over the entire cavity, but the rigid bony walls do not permit the drawing together of the granulating surfaces The skin at the margin of the cavity begins to turn in and a thin layer of epithelium dips down over the granulations Very shallow grooves and cavities may become covered over in this way, but in larger cavities, after advancing a certain distance, the epithelium no longer grows, little new bone is formed beneath the granulating area and the cavity often remains nearly the same size year after year Sargent¹ records a cavity three inches long from which, sixteen years before, a four-inch sequestrum had been removed

Healing can only occur if, beneath the granulating surface, new bone or new connective tissue is formed, and thus the level of granulations is gradually raised until the cavity is filled up and the skin heals over the surface Healing, however, rarely occurs in this way, but that it does occur occasionally is shown by the case reported by Doctor Mathews, in which a large cavity, left after curetting away a giant-cell sarcoma in the head of the tibia four years ago, is soundly healed, and yet the X-ray shows a defect in the bone still present This cavity is undoubtedly filled with fibrous tissue, and I have recently had the opportunity of seeing a cavity, about 1 cm in diameter and 2 cm in depth, following osteomyelitis, soundly healed for years which was completely filled with fibrous tissue The bone at the margin of the cavity was eburnated, but at the bottom of the cavity the tissue looked like cancellous tissue and the connective tissue plug was firmly adherent to this portion

⁺ Read before the New York Surgical Society, October 8, 1910

There are many examples of healing after this manner shown in the bone cavities produced in animals for experimental purposes. It must be remembered that for sound healing restoration of the bone is not essential, a bone cavity may be filled with fibrous tissue. But in the great majority of large bone cavities, especially those following traumatic osteomyelitis, the cavity will not fill up and healing does not occur, and the surgical treatment of the cavity is as important as the removal of foci of infected bone or the extraction of a sequestrum. Renfrew J White² suggests that the reason lies in the lessened vascularity due to the duration of the reparative process, the stage of cicatricial contraction having set in, osteosclerotic changes progressively denser, thicker and less vascular limiting cell proliferation. Sargent suggests that the full maturity of the new-formed fibrous tissue has been reached. But in many instances there is little or no osteosclerosis. I have seen unhealed bone cavities at the lower end of the tibia in which osseous tissue making up the walls was soft, vascular and easily scraped away, even after the cavity had remained open for years. Moreover, in chronic bone abscesses (Brodie's) there is much osteosclerosis, yet if the abscess is opened, the soft parts heal over the bone satisfactorily. May it not be that environmental conditions, such as the desiccation and irritation of granulations by the air, contact with dressings, solutions, surface bacteria, dirt, etc., are unfavorable for such exuberant growths and such elaborate repair as would be necessary for the replacing of large bone defects? A condition of repair and interference with repair is reached analogous to ulceration in the soft parts.

It has been long recognized that the most satisfactory method of dealing with a cavity with rigid walls is the removal of such portions of the bony wall as will permit the soft parts to come in contact easily with the remaining underlying bone, the replacement of an unyielding wall by a yielding wall. This means usually the conversion of the cavity into an open gutter. It presupposes complete removal of all foci of osteitis and every morsel of necrotic tissue or sequestrum. It means, in many instances, a most formidable and extensive operation.

In Cases IV, V, VI, and VII, I have shown examples of this method of treatment. It is the treatment recommended recently by Broca, by Chabier,³ by Sargent and by Renfrew White.

However, in bone cavities in close proximity to a joint, the removal of the roof and side walls, with the idea of allowing the soft parts to fall in, may be almost impossible or necessitates a very difficult flap or plastic operation with damage to sound tissue. Moreover, in certain tunnels following compound fractures, the removal of all the bone on one side of the tunnel leaves the shaft very weak and with poor mechanical support (Fig 1). To be sure, there is ample evidence of the extraordinary power of bone regeneration in young subjects after the removal of large portions of the shaft, and even evidence of formation of bone from connective

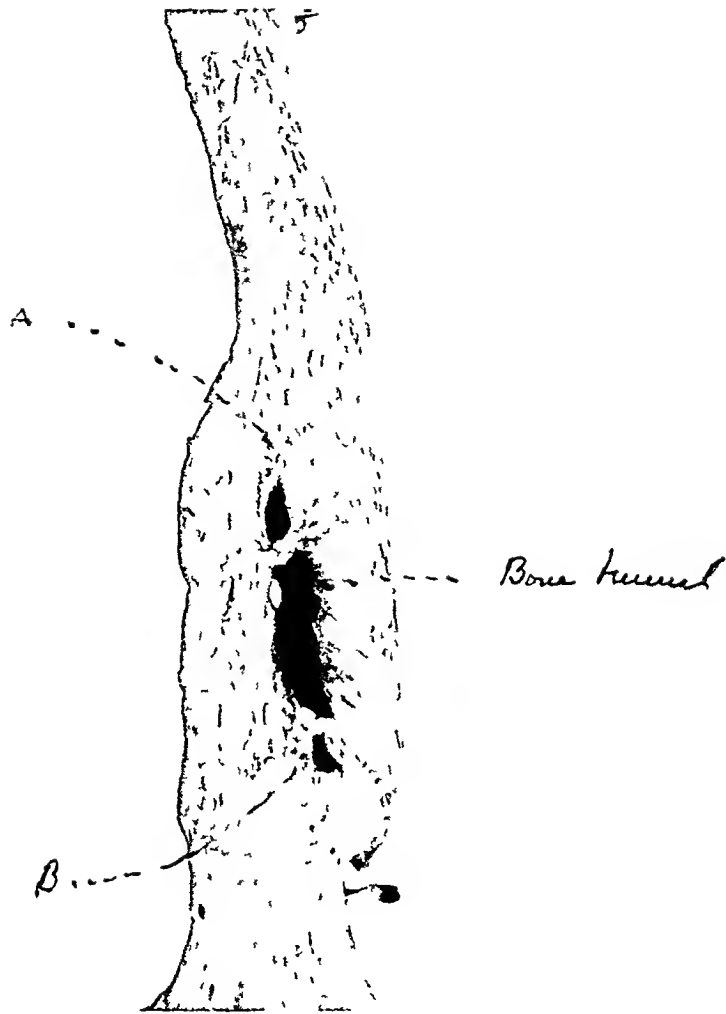


FIG 1 —Old compound fracture of femur showing bone tunnel A B shows how bone would be weakened by excision

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tissue, apart from any osteoperiostic activity. But it is to be remembered that infection has, in many of these cases, impaired the osteogenetic properties of the cells, nor do we yet know what are the conditions favorable for the transformation of connective tissue into bony tissue, for creating

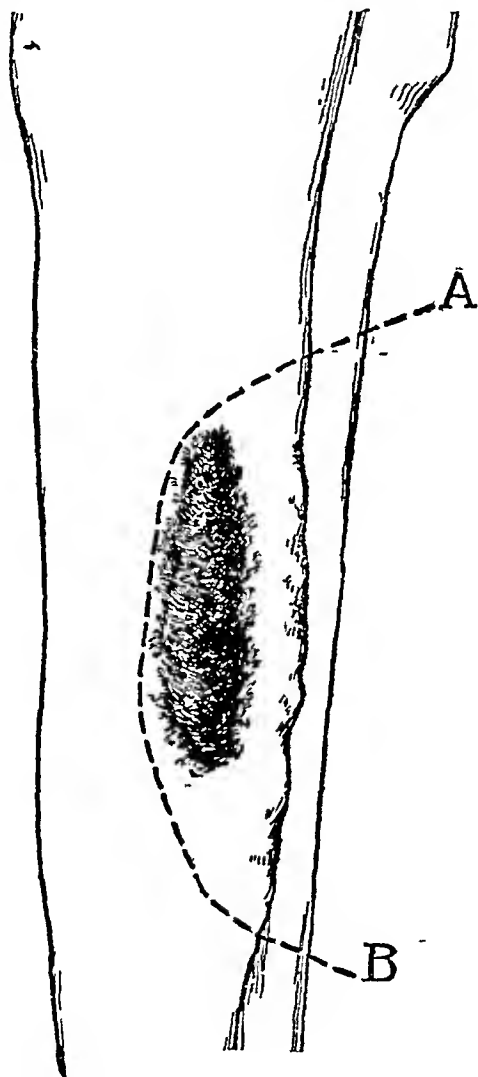


FIG 2 —(Case IV) Outline drawing from X-ray plate of tibia A|B, line of excised bone Dark area represents bone cavity

what Leriche⁴ calls the “milieu ossifiable” Nor do we know the conditions causing exhaustion of the reparative process

For these reasons I wish to call attention to some of the other methods of closing bone cavities For the last fifty years there have been numerous attempts to secure healing by plugging the cavity rather than by obliterating it Many substances have been used, such as gypsum, copper amalgam, gutta percha, various cements, bismuth paste and absorbable materials, such as sterilized pieces of sponge, rolled-up catgut, starch and iodoform, decalcified bone chips, etc None of these methods produced results sufficiently satisfactory to lead to their general use In 1903 Mosetig-Moorhof published a number of cases in which bone cavi-

ties had been closed satisfactorily by a plug made of iodoform, spermaceti and sesame oil. He developed a very elaborate technic. The bone cavity was most carefully prepared with chisel and electrically driven burrs and saws, the walls being cut away until smooth, sound bone was reached on all sides. The cavity was then dried by a blast of hot air and finally the warmed plugging material poured in, every care being

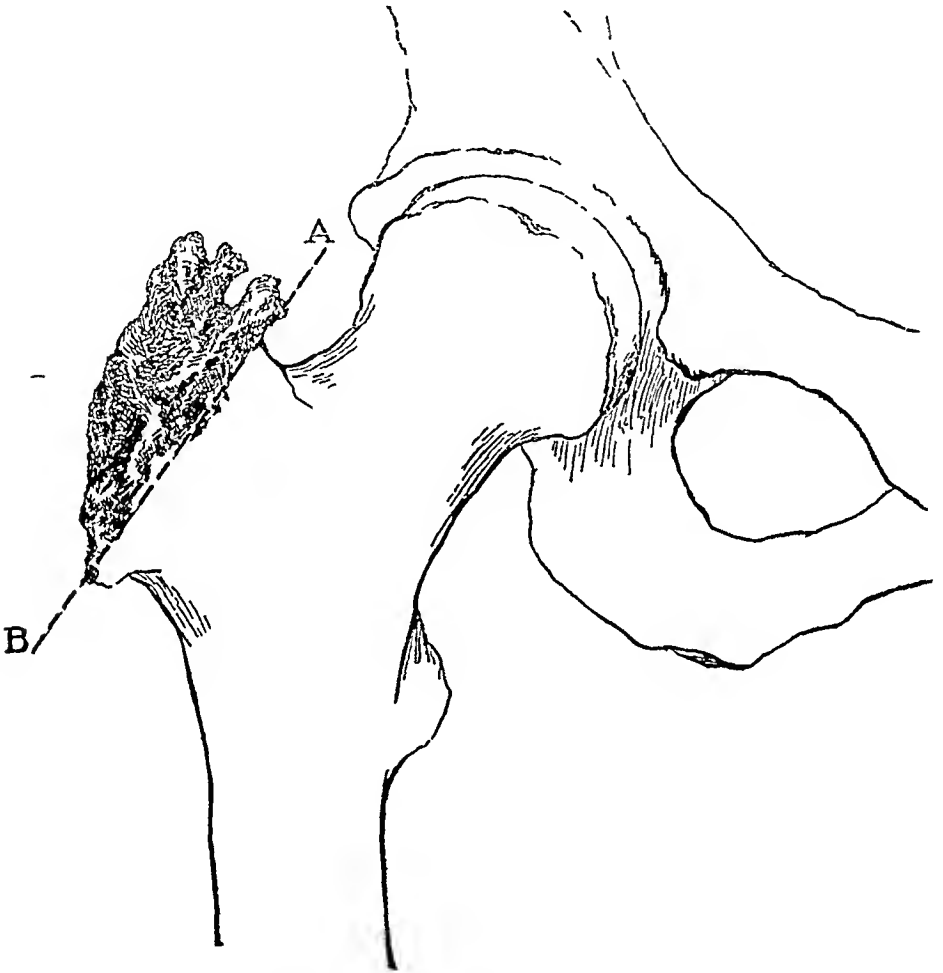


FIG 3 —(Case VI) Outline drawing from X-ray plate of femur. A B shows line of excision. Shaded area shows diseased bone.

taken to fill completely the excavation. After the material hardened the soft parts were accurately sutured.

In the cases where the soft parts healed, it was found by X-ray examination that the bone defect gradually grew smaller and that the plug was slowly absorbed. In 1904 Silbermark⁵ reported a number of experiments on animals in which he had introduced the Moseley mixture into cavities made in the metatarsal bones of dogs. He found that the material was absorbed and the defect gradually filled with new bone.

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Since then there have been many satisfactory results published in which this method was used, but the technic is complicated, the sterilization of the plugging material not without difficulties, and in many instances fistulæ form from which is discharged the oily part of the mixture and granules of iodoform and spermaceti. These fistulæ easily become infected. My own experience is limited to its use in cavities following

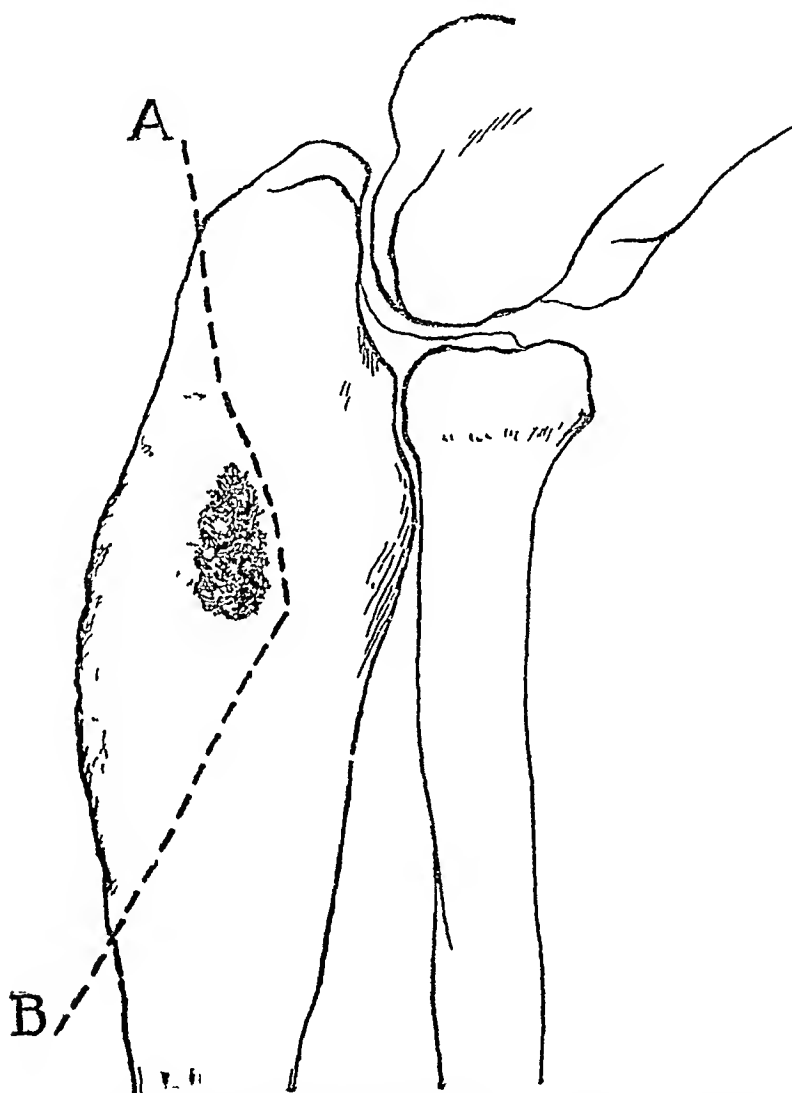


FIG 4 —(Case VII) Outline drawing from X-ray plate of ulna A B, line of excised bone Shaded area shows bone cavity

bone tuberculosis. I have had one case of severe iodoform poisoning following resection of the hip, a case reported in this society ten years ago. In this case, however, dry iodoform powder was used.

It has long been known that in local suppuration in bone—a condition usually described as Brodie's bone abscess—if the cavity is exposed and one of the walls cut away so that there is no overhanging roof left, the soft parts can be brought together and the skin sutured. The cavity fills with blood which is gradually replaced with new-formed tissue. The

microorganisms have not sufficient virulence to infect the blood clot—Cases I, II, III, etc This was the method of treatment recommended by Watson Cheyne⁶ twenty or more years ago and it is to-day the most satisfactory treatment for small, chronic, localized abscesses surrounded by eburnated bone In these cases it is unnecessary to carry out an

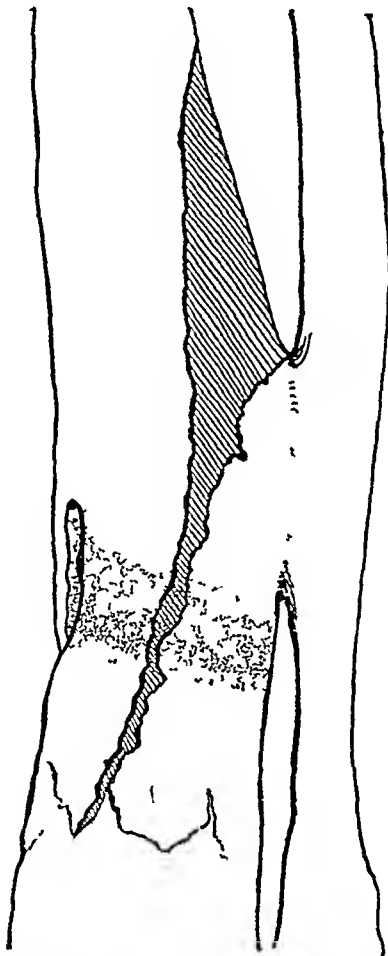


FIG 5 —(Case VIII) Outline drawing from X-ray plate of tibia Dotted area shows tunnel in tibia Shaded area shows line of old fracture and new bone

extensive removal of the bone with the idea of obliterating the cavity, nor is it necessary to fill the cavity with fat, fragments of muscle or plugging of any kind Long experience gained since Brodie first lectured on this interesting condition, seventy-three years ago, has shown that the soft parts will heal soundly after the evacuation of the abscess

If a blood clot remains uninfected it furnishes an excellent medium for regeneration of new connective tissue and bone, and Schede's method of filling tissue defects with an aseptic blood clot is based on this fact We are all familiar with the growth of new bone into the blood clot after a

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simple fracture and many of us have followed Bier's⁷ suggestion of injecting blood in ununited fractures to promote osteogenesis Bancroft,⁸ with the idea of studying repair in bone cavities, made excavations in the diaphysis of the humerus in dogs Every effort was made to secure hæmostasis, but after the soft parts were closed the bone cavities regu-

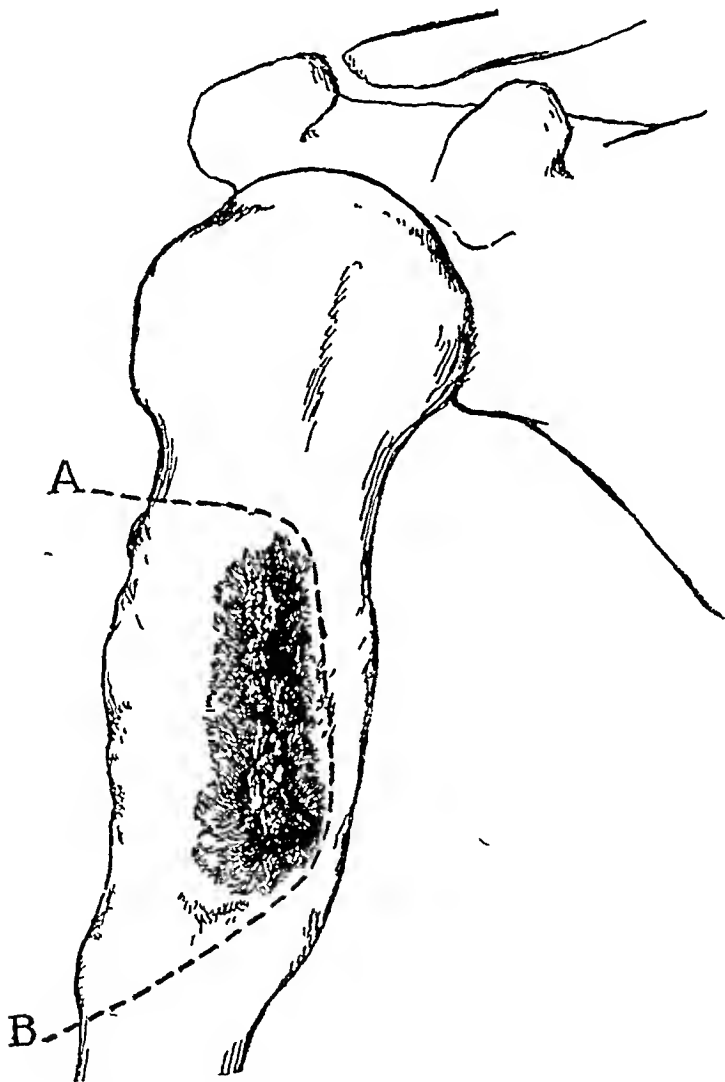


FIG 6 —(Case IX) Outline from X-ray plate of humerus AB, line of excised bone Shaded area shows bone cavity

larly filled with blood At the end of twelve days there was evidence of the early formation of new bone In animals killed after four months it was difficult to detect the site of bone cavity New bone had completely replaced the blood-filled excavation

But blood clot is readily infected Dorst has shown that the susceptibility is increased forty-fold for the staphylococcus if a hæmatoma be present Furthermore, skin sutured over a collection of blood does not heal satisfactorily, even if there is no infection. In running the finger over certain scars ten days or two weeks after an operation defects are

sometimes felt where there has been a collection of blood due to failure of exact hæmostasis. At these places the skin is generally thinned as if the blood had forced apart the corium and underlying connective tissue to a certain extent, preventing exact apposition. For these reasons, a bone cavity of considerable size will almost certainly not heal if allowed to fill

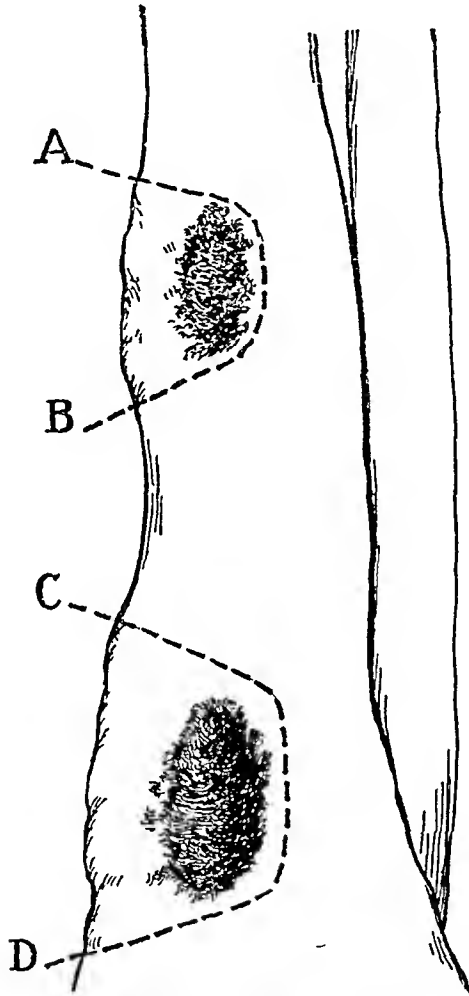


FIG 7 —(Case X) Outline drawing from X-ray plate of tibia. A B and C D, lines of incision in bone. Dark area represents bone cavity.

with blood and the soft parts closed, even if the cavity is apparently sterile.

Although Neuber, in 1893, reported a number of cases of patients in which free fat had been transplanted successfully in the soft parts to fill defects, it was not until ten years later that Chaput reported four cases in which he had successfully plugged bone cavities following osteomyelitis with fat. Since then twenty-one cases have been reported in France, twenty-four in Germany, one in Italy and four recently by Rutherford Morison in England. Makkas,⁹ in 1912, reported a number of experiments in which he had transplanted fat into cavities made in the lower ex-

tremities of the femur of dogs. In one of the large animals the cavity made was said to be the size of an egg, and in one the cavity was cut through into the joint so that the fat plug was placed in a bone tunnel, one end of which projected into the articular cavity. The fat mass was taken, in each instance, from the hypogastric region of the same animal. In seven out of eight experiments he secured sound healing. He killed the animals at periods varying from one month to three months. In the majority of the animals the fat plugs had been replaced by a gelatinous connective tissue. In one, curiously enough the one in which the fat had been transplanted for the longest time, the plug was still composed of normal fat. In each instance apparently an osteoplastic layer was in contact with the fat graft and the cavity seemed to have grown smaller. In the dog in which the fat perforated the articular cavity, there was no sign of joint irritation or joint adhesion. Calforio,¹⁰ in March, 1918, reported the result of small fat transplants in cavities made in the upper extremity of the tibia in rabbits. From these experiments he concluded, first, that the fat did not remain as such in the bone, and second, that it was completely substituted by new-formed osteoid tissue.

X-ray observation of the fat transplanted in bone in man shows apparently similar results, in some instances little or very little replacement by bone, in others, as shown in Figs 12, 13 and 14 of Morrison's article, almost complete replacement of fat by bone in a few months. In Case VIII of this series the cavity, examined two years after the fat transplant, is still apparently not filled with bone. We have, then, in fat a material which has been proven, both experimentally and by actual practice, suitable for plugging bone cavities. It has certain obvious advantages. It does not readily support bacterial life, nor does it readily undergo decomposition. I have here a mass of human fat, removed last August and exposed to the dust and air in an open window. The mass has shrunk somewhat, has hardened a little and become a darker color on the outside. There is a slight odor resembling that of butyric acid. A second piece I have put in tap water in an open, wide-mouthed bottle for ten days. It presents no material alteration, but there is a very faintly disagreeable odor and the water is cloudy. Moreover, when fat is broken down by the enzymes of bacteria it probably splits into fatty acids or their salts (soaps) and glycerine. Neither are especially harmful to the tissue. Further, there is no tissue in the body that undergoes normally such frequent change, the cells under varying conditions of nutrition losing or gaining their fat content. In other words, fat seems to be easily taken up by the body cells and from the body cells, for the fat cell, after all, is only a connective tissue cell in which the accumulation of fat in the cytoplasm has reduced the cell to little more than a vesicle surrounding the fat. The fibrillar connective tissue which follows the blood-vessels and holds the mass together is very scant. Again, fat presents a material which has physical properties suitable for healing of the overlying skin,

for the subcutaneous areolar tissue normally contains fat. For the success of the transplant the bone cavity must be carefully prepared. If the wall is not everywhere made up of sound bone, if there is a tiny morsel of necrotic bone, foreign body or area of osteitis, the result will almost certainly fail. I have followed the plan, during the last three years, of doing a two-stage operation in all bone cases, first laying open the bone cavity, removing the sequestra, area of osteitis and smoothing off the walls. Then for ten days to three weeks flushing the cavity systematically with Dakin's solution, following the Carrel technic. Finally, when the cultures show no organism present but the staphylococcus, and these only one in two or three fields in smears, the second operation of closure of the soft parts is attempted. In nearly every instance I have, during this period of treatment, removed a small particle of dead bone overlooked or detached at the first operation.

When it is decided from the nature of the cavity or tunnel that a fat transplant is suitable, the skin is excised about the margin of the cavity and freed from the underlying tissue until its edges can be brought together. Exact hæmostasis of the soft parts is essential, the fat itself serving as a plug to help stay the hemorrhage from the bony walls. The fat is then excised, a piece being taken that is distinctly larger than the cavity. I have used the subcutaneous fat from the abdominal wall in each instance. In Cases IX and X the patients were lean young men with a scant fatty layer and the fat pad was thin. This fat is thrust into the cavity, the end of graft mushrooming through the opening in the bone. The skin is then closed over the graft by interrupted sutures. In every instance this has been the most difficult part of the operation. In each of the patients there had been several previous operations, so that the skin was found bound down to the bone and soft parts by cicatrices. In no instance have I been able to get very accurate skin approximation, portions of fat protruding in the intervals between the skin sutures. In one instance the skin was undermined for half the circumference of the leg. Parallel freeing incisions would have aided in this case the sliding over of the skin. The wounds have not been drained. After dressing with sterilized gauze a light plaster bandage has been applied. In no case was there a rise of temperature. The dressing was removed on the eighth day.

In Case VIII there was a small dark crust made up of dried blood and protruding fat. This fell off at the end of three weeks, the epithelium had healed beneath it. In Case IX a portion of the skin parted on removing the sutures and part of the fat sloughed. There was no rise of temperature or sign of infection, and it was soundly healed in three months. In Case X two cavities were filled with fat. One healed. In the second cavity there was a slight separation of the skin over a distance of five mm. At this point there was a small slough when last seen, two months after the operation.

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In treating infected bone cavities the following conclusions may be drawn:

1 That complete removal of all the infected bone lining the cavity, of all foreign bodies and of every particle of dead bone is essential

2 That in the great majority of cases the cavity must be obliterated to insure healing

3 That this is most satisfactorily accomplished by the removal of sufficient portions of the wall of the cavity to allow the soft parts to fall in and fill it up

4 That in certain tunnels and cavities near joints some form of plugging may be indicated

5 That of the many materials used as plugs the free fat transplants present real advantages

6 That the two-stage operation, with careful sterilization of the cavity under bacteriological control, following the Carrel-Dakin technic, is of great value

7 That in the small chronic bone abscesses in the ends of long bones with attenuated infection no filling or intermediate sterilization is necessary

CASE RECORDS

CASE I (*Chronic Suppurative Osteomyelitis*—Brodie's Bone Abscess—*Bacillus Typhosis*)—W F, aged sixty-five years Admitted St Luke's Hospital December 15, 1912 Discharged January 17, 1913, cured

Present History—Slight pain for three weeks over lower end of tibia, then intense pain and tenderness for several days

Previous History—Typhoid fever forty-four years ago About a year later began to have pain in leg An incision made in skin from which pus escaped, sinus persisting fourteen years After sequestrum one inch long removed, leg healed and remained healed and painless for thirty years

Physical Examination—Over lower end of tibia bone enlarged, intensely painful on pressure at one point X-ray shows great thickening of bone, shadow too dense to show bone cavity

Operation—Sclerotic bone chiseled away, abscess evacuated, wound sutured Primary union Pure culture of typhoid bacillus obtained from pus Widal negative Seen four months ago Leg still soundly healed six years after operation Shown at New York Surgical Society March 28, 1917

CASE II (*Chronic Suppurative Osteomyelitis of Tibia*—Brodie's Bone Abscess—*Staphylococcus Aureus*)—I L, aged twenty-seven years Admitted St Luke's Hospital December 7, 1915 Discharged January 7, 1916

Previous History—Nineteen years before admission had periostitis in both tibiae Occasionally since then small sequestra have been discharged No persistent sinus

Present Illness—Three weeks ago he developed pain in the left

leg with slight swelling above the ankle No trauma Intense pain, worse at night, in lower part of leg Tender on pressure

Operation—Sclerotic bone removed with chisel, pus evacuated from cavity size of cherry, skin sutured, no drainage Seen two years after operation Bone still soundly healed Shown at New York Surgical Society March 28, 1917

CASE III (*Chronic Suppurative Osteomyelitis of Right Tibia*—Brodie's Bone Abscess)—F P, aged thirty-one years Admitted St Luke's Hospital February 1, 1917 Discharged March 30, 1917

Present Illness—Four weeks before admission sudden onset of pain and swelling of right leg below knee No history of trauma

Previous History—Negative

Operation—Sclerotic bone removed with chisel Pus evacuated, packing for twenty-four hours Secondary suture, primary union Soundly healed one year later Shown at New York Surgical Society March 28, 1917

CASE IV (*Chronic Suppurative Osteomyelitis of Right Tibia*)—Mrs H T, aged forty-seven years Admitted St Luke's Hospital February 23, 1910 Discharged March 25, 1910

Present Illness—Seven weeks before admission struck right leg Since then has been unable to walk and has had a slight purulent discharge from an old sinus in the middle of right tibia

Previous History—When fourteen months old had osteomyelitis of right arm and leg Incision by Doctor Buck Arm healed, but from time to time she has had discharge from the right tibia and attacks of severe pain

Operation—February 26, 1910 Tibia exposed, necrotic bone removed No careful effort to approximate soft parts

Readmitted September 11, 1918 Six years later Sinus has persisted and she has had intense pain in leg from time to time since last operation

First Operation—September 24, 1918 Resection of anterior and internal wall of abscess cavity and removal of bone until sound bone was reached on all sides of excavation Carrel-Dakin treatment for one month

Second Operation—October 24, 1918 Closure of soft parts Four weeks later small pocket of pus under skin in soft parts Incision Healed two weeks later Soundly healed, free from disability eleven months after operation Shown before New York Surgical Society October 8, 1919

CASE V (*Chronic Suppurative Osteomyelitis of the Femur*)—Dr R G, aged forty-five years Admitted St Luke's Hospital June 27, 1916 Discharged October 9, 1917 Operation three months previously for chronic suppurative osteomyelitis Has had a persistent sinus opening on inner side of thigh Several operations for drainage were performed during the summer and autumn of 1916 During this period secondary pockets formed in the popliteal space and to the outer side of the thigh Leg became flexed on the thigh In July, 1917, the whole wound tract was laid open, sinuses were ex-

cised, cortical portion of the femur chiseled away and two small sequestra were removed, leaving a comparatively smooth bony gutter into which the soft parts could be crowded. The wound closed very slowly, the two folds of soft tissue turning in against the bone. The knee gradually regained its mobility. The wound has been soundly healed for one year. Shown before New York Surgical Society October 8, 1919.

CASE VI (*Chronic Suppurative Osteomyelitis of Right Femur*) — T. E., aged thirty years. Admitted St. Luke's Hospital January 22, 1919. Discharged March 24, 1919.

Present Illness — For last sixteen months discharging sinus in right thigh.

Previous History — Fifteen years ago had an attack of pain in right thigh. Thigh was opened, sinus persisted for a few months, then remained closed for eleven years. Four years ago sinus again opened, was curetted and remained healed until present attack. No disturbance of function.

Physical Examination — Shows a long scar extending from the greater trochanter down the outside of the thigh. In the centre of the scar is a sinus communicating with the femur.

First Operation — January 28, 1919. Four sinuses extending between gluteal muscles excised, external part of greater trochanter chiseled away. Carrel-Dakin treatment instituted.

Second Operation — February 13, 1919. Edges of wound excised and wound closed by interrupted sutures. Primary union. Seen one week ago. Leg soundly healed. Has developed tuberculosis of the lungs.

CASE VII (*Tuberculous Osteomyelitis of Right Ulna with Secondary Pyogenic Infection*) — L. G., aged eleven years. Admitted St. Luke's Hospital December 7, 1918. Discharged July 15, 1919.

Present History — Sinus leading to bare bone has been repeatedly curetted in the Out-Patient Department, but discharging sinus still persists. X-ray examination shows much thickness of ulna with a distinct cavity.

First Operation — Sinus excised, subperiosteal resection of the upper part of ulna forming the inferior wall of the bone cavity.

Second Operation — Five weeks later. Closure of the soft parts. Healed. Has since developed a tuberculous abscess of anterior surface of forearm.

CASE VIII (*Chronic Suppurative Osteomyelitis of the Tibia*) — Ensign W. T., aged twenty-two years.

Previous History — Fell from cliff in 1913, sustaining a compound fracture which became infected. Has had eight operations for removal of sequestra and for drainage. Wound would heal and then break open. In December, 1917, sinus again opened. X-ray showed union of old fracture of tibia and fibula with deformity and with a tunnel through the junction of tibial fracture.

First Operation — Excision of skin about sinus and removal of

sides of tunnel until sound bone reached Two small sequestra also removed Carrel-Dakin treatment

Second Operation—Skin edges excised Free fat transplant taken from subcutaneous fat of abdominal wall and placed in bone tunnel Skin approximated by interrupted sutures Healed Shown before New York Surgical Society October 8, 1919

CASE IX (*Chronic Suppurative Osteomyelitis of Humerus Following Gunshot Injury*)—E B, aged twenty-one years Admitted St Luke's Hospital February 28, 1919 Discharged May 5, 1919

Present Illness—On September 29, 1918, was wounded with a piece of shrapnel in the upper part of right humerus Discharging sinus ever since

Physical Examination—Shows a wound on the antero-external aspect of the upper part of right arm Wound of exit on posterior surface of arm There is still a discharge of pus from the external one

First Operation—March 11, 1919 Wall chiseled away from one side of bone cavity and ten sequestra removed Dakin treatment instituted until smears showed one staphylococcus per field Streptococci absent

Second Operation—April 8, 1919 Removing side walls to make gutter of bone cavity more shallow

Third Operation—April 24, 1919 Piece of fat 10 cm by 5 cm transplanted from abdominal wall to cavity Skin edges freed and sutured Difficulty in approximating edges, scar tissue on outer side unyielding

Clinical Notes—Sutures removed eighth day Upper part of wound separated exposing fat graft Exposed graft at the end of several weeks looked like a whitish slough extruding small droplets of oily material At the end of two months a small slough separated and was removed During this time there was a distinct rancid odor about the wound and the epithelium at its margins was macerated At no time was there any temperature nor evidences of pyogenic infection Wound healed July 25, 1919 Shown before New York Surgical Society October 8, 1919

CASE X (*Chronic Suppurative Osteomyelitis of Left Tibia*)—F K, aged twenty-seven years Admitted St Luke's Hospital December 10, 1918 Discharged March 27, 1919

Previous History—Five years before admission developed osteomyelitis of left tibia following injury at football Sinus persisted for two years and then remained healed for three years

Present Illness—Four months ago old wound broke down Three operations curetting bone Still has discharging sinus

First Operation—January 17, 1919 Cortex of bone was removed from the anterior portion of the lower part of the tibia Two cavities exposed, one containing pus and connected with sinus, other cavity filled with granulations

Second Operation—January 23, 1919 Skin edges freed Two

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fat pads transplanted from the abdominal wall to fill in both bone cavities Skin closed with interrupted sutures

March 27, 1919 Patient discharged, wound healed, except for small portion of fat exposed in lower wound about size of head of a pin Patient left for Australia and has not been heard from

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THE TREATMENT OF CENTRAL LUXATION OF THE FEMUR*

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THIS paper is practically limited to the consideration of fracture of the base of the acetabulum with penetration of the femoral head, uncomplicated by extensive fracture of the pelvis or injury of its contents, in other words, to the class of cases in which the chief concern is the functional result as affected by treatment

The cause of the injury is usually direct force applied to the trochanter, the immediate penetration being increased possibly in some instances by subsequent weight bearing

The physical signs, although sufficiently distinctive, are often overlooked at the time of the accident

The prominence of the trochanter is lost The limb is somewhat flexed, adducted, and slightly shortened There is a fair range of flexion and extension, but rotation is very limited, and abduction is almost completely restricted because of the contact of the trochanter with the acetabular rim There are usually sensitiveness and other evidences of local bruising of the tissues, and movements of the limb are painful, but as there are no evident signs of fracture the injury often passes as a contusion

When weight bearing is attempted, pain is increased and is reflected down the inner and posterior region of the thigh, caused apparently by pressure on the nerves passing in the neighborhood of the displaced femoral head

The persistence of pain, stiffness and limp leads to further investigation, and the diagnosis is finally established by X-ray examination weeks or months after the injury In this connection I may note that many years ago I was present at an operation for supposed pelvic tumor which disclosed the head of the femur, the previous history of injury and the physical signs of the displacement having escaped the attention of the surgeon

In my experience, at least, there has been no opportunity for immediate treatment, nor does it appear that the methods usually employed when the diagnosis has been made have been successful in permanently reducing the displacement

These are forcible manipulations under anæsthesia or the application of traction, either longitudinal or combined with a lateral pull In the first instance the displacement, if reduced, usually recurs when the limb is placed in the normal attitude, while traction is not often effective in withdrawing the head from the pelvis

The final results are reported as fairly satisfactory, probably as com-

* Read before the New York Surgical Society, November 26, 1919

TREATMENT OF CENTRAL LUXATION OF THE FEMUR

pared with those of fracture of the neck of the femur. It may be assumed that after a time accommodative changes will relieve the pressure on the nerves and increase the mobility of the new articulation, but the restriction of abduction must persist, and consequently insecurity, apparent shortening and limp. The practical indication in treatment, therefore, is to assure a sufficient range of abduction, which from the functional standpoint is of far greater importance than the reduction of the dislocation, although the one is necessarily dependent on the other. This may be accomplished by the abduction method as applied for fracture of the neck of the femur, although the mechanism is quite different.

Under normal conditions the trochanter is apposed to the upper border of the acetabulum only at the limit of abduction, and in the treat-

DIAGRAM TO ILLUSTRATE THE MECHANISM OF THE ABDUCTION METHOD

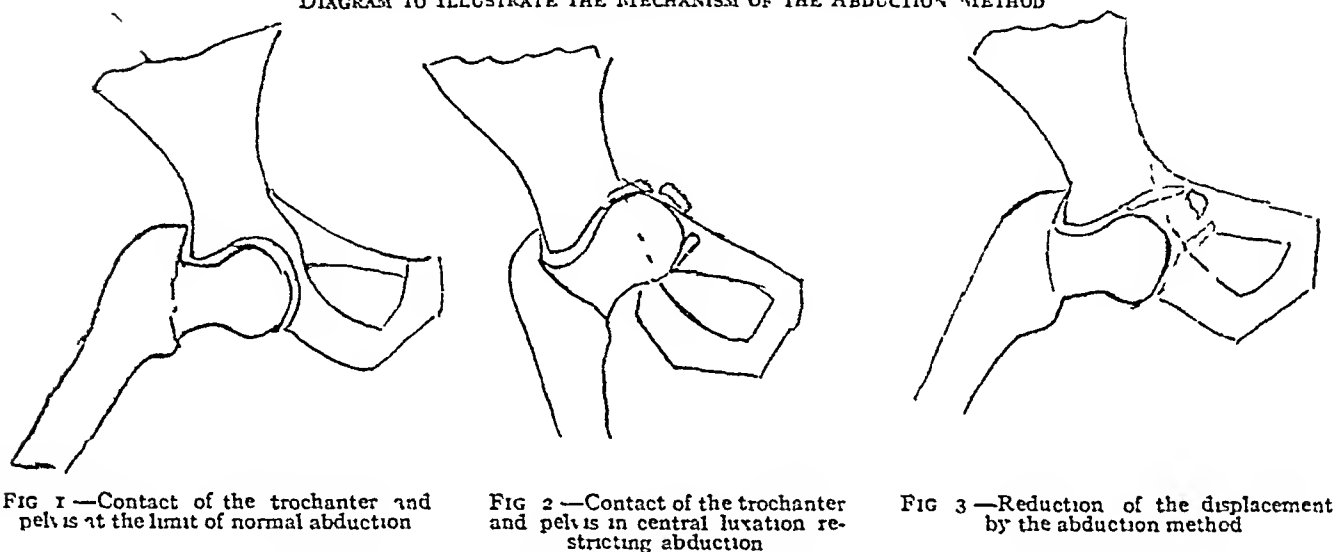


FIG 1—Contact of the trochanter and pelvis at the limit of normal abduction

FIG 2—Contact of the trochanter and pelvis in central luxation restricting abduction

FIG 3—Reduction of the displacement by the abduction method

ment of a fracture it is desirable that the limb should be fixed in the degree of abduction that establishes such contact (Fig 1).

In this instance the head of the femur having been driven inward, the trochanter is apposed to the acetabular rim when the limb is in the line of the body (Fig 2). This furnishes a point of resistance or fulcrum against which the leverage of the extended limb may be utilized to withdraw the head of the femur from the pelvis (Fig 3).

The patient, having been anesthetized, is placed on a pelvic support, provided with a perineal bar, the two extended limbs being supported by assistants, who draw the patient firmly against the perineal bar. The sound limb is then abducted to the normal limit to fix the pelvis. The other limb in the extended attitude and under manual traction is then gradually and forcibly abducted, if practicable, to the normal limit, which should indicate the complete withdrawal of the head from the pelvis, and in this attitude a plaster spica is applied extending from the line of the nipples to the knee.

It is possible, if the patient were treated soon after the injury, that the displaced acetabular floor might be reduced somewhat by pressure

through the vagina or rectum, but in the cases that I have seen, the lapse of time has made this impracticable, and in most instances one must depend upon the gradual obliteration of the cavity by natural processes to prevent redisplacement. The plaster spica must be retained, therefore, with this end in view for several months, locomotion being permitted as soon as it does not increase the discomfort, since displacement is impossible in the abducted attitude. After the support is removed, the limb must be passively abducted to the full limit at frequent intervals, until the patient has regained voluntary control of this movement.

This treatment is designed primarily for uncomplicated cases, in which natural mechanics may be utilized. If the pelvis were so fractured that effective leverage could not be employed because of the lack of a resistant fulcrum, one would attempt to secure a sufficient degree of abduction by direct manual traction combined with gentle lateral movement of the limb.

It is possible, also, if the opportunity for immediate treatment were offered, that the head might be disengaged by direct manipulation, as by pressure on the knee after flexing and adducting the thigh. Under ordinary conditions, however, the accommodative changes will have so increased the resistance, that this manipulation is not likely to be successful, and in any event disengagement is merely preliminary to fixation in extension and abduction.

The range of abduction is dependent upon the distance between the trochanter and the acetabular rim, and it is determined by their apposition. Complete abduction indicates, therefore, complete disengagement of the head, and a limited range a corresponding incompleteness of reduction.

If the resistance has become so great that the head cannot be withdrawn by natural leverage, an osteotomy below the trochanter is indicated, since the purpose of treatment is to secure and to retain a sufficient range of abduction for functional requirements.

Intrapelvic exploration would seem to be a doubtful expedient. In recent cases the displacement should be easily reduced by the abduction method, while if of long standing the prospect of improved function would hardly justify the risk.

The following case, which has served as the text for this paper, is one of six that have come directly or indirectly to my notice, indicating that the injury is not adequately represented by statistics.

The patient, a man of thirty-five years of age, was injured by the overturning of an automobile on September 28, 1918. He was taken to a hospital and after examination was discharged with a diagnosis of contusions. He remained in bed for about three weeks, suffering from stiffness and pain in the right hip and thigh, which was increased by weight bearing. Seven weeks later he came to the Hospital for Ruptured and Crippled, walking with the aid of a cane, presenting the physical signs typical of the injury, as illustrated by



FIG 4 —Showing contact of the trochanter and acetabular rim limiting abduction



FIG 5 —After reduction by the abduction method Taken through the plaster spica



FIG. 6 —One year later showing the obliteration of the cavity. The reduction of the displacement though incomplete, has increased the range of abduction from 0° to 30° which is sufficient for functional use

the accompanying X-ray picture (Fig 4), which shows also a fracture of the ischium. He was admitted to the hospital and with some force the limb was abducted nearly to the normal limit (Fig 5). The pain was immediately relieved, and he soon began to walk about without discomfort. Seven weeks later the plaster support was removed tentatively, but unfortunately the patient was obliged to return to his work to the neglect of after-treatment, and was not seen again until July. At this time the limb was somewhat flexed, slightly adducted and motion was much restricted. There was, however, but little discomfort on use. He was again admitted to the hospital and the operation was repeated, the abduction being forced to about 40 degrees. The plaster spica was removed at the end of ten weeks and the limb could then be abducted to 30 degrees (Fig 6). He has returned to the hospital for stretching at intervals and in spite of the lack of other accessories of after care he retains a sufficient range of abduction for functional requirements and has but little discomfort and but slight limp.

It is apparent that if a sufficient range of abduction is attained by the manipulation, its retention can be assured by fixing the limb for a sufficient time to permit the accommodative changes in the tissues. This time should vary, therefore, with the duration of the displacement, and the quality of the after-treatment at command, and fixation should again be employed if the range of abduction progressively lessens. It is evident, therefore, that in the case described this period was far too short, although it might have been sufficient if the reduction had been accomplished immediately after the injury.

This latest application of the principles of the abduction treatment illustrates its wide range of practical adaptability. Nearly all the so-called disabling contusions about the hip are in reality fractures of the femur or of the pelvis, and either because of uncorrected deformity or as an instinctive adaptation to weakness and pain, the limb usually becomes flexed and adducted.

In all obscure injuries in this region, therefore, the abduction method might be applied with advantage as for fracture of the neck of the femur, since it is the only efficient means of adjusting and fixing the fragments if this is broken, while if the pelvis is injured, restraint of the limb is required for effective splinting. The abduction treatment has the further advantage that immediate correction of deformity, the first essential of success, is supplemented by an after care conducted with a definite aim and guided by physical signs that indicate the progress of reconstruction upon which functional recovery depends.

GUNSHOT FRACTURES OF THE TIBIA AND FIBULA *

OBSERVATIONS ON THE PATHOLOGY AND TREATMENT

By FREDERICK CHRISTOPHER, M D

OF CHICAGO, ILL

FORMERLY 1ST LIEUT M C, U S A

AMERICAN RED CROSS MILITARY HOSPITAL No 2 was located in Paris and generally functioned as a base hospital. However, during June, July, and August, 1918, with heavy fighting in the region of Château-Thierry, some 65 kilometres away, the hospital acted almost continuously as an evacuation hospital. At such times cases were received as early as twenty-four hours after having been wounded and without other treatment having been done than their first-aid dressings. At other times the cases were received on an average of from three to four days after the injury and after they had been submitted to an operation at field or evacuation hospitals. In view of the necessity of making room for incoming wounded during the rush periods, it was necessary to evacuate cases as rapidly as possible to hospitals further back. While an effort was always made to hold fracture cases until union was well under way, it was often unavoidable to evacuate them a few days after admission. As compared to ununited fractures of other long bones, those of the tibia and fibula seemed, perhaps best of all, to stand early transportation. Accordingly, the records of gunshot fractures of the tibia and fibula show considerable variation as to the duration of the stay of the patient in the hospital.

Colonel Blake¹ has said "Fractures of both bones tend to overlap and also to interlock in bad positions, and are often difficult to reduce, moreover, repair in the leg seems more indolent than elsewhere in the body, and these fractures sometimes unite very slowly and imperfectly. The lack of soft parts over the tibia possibly accounts for some of such cases of delayed union, sluggishly granulating wounds and disagreeable scars." In view of the difficulty that may be encountered in the treatment of cases of this kind, it may not be amiss to make a few remarks on the cases at this hospital.

At American Red Cross Military Hospital No 2, from November 1, 1917, to about January 1, 1919, there were treated 43 gunshot fractures of the tibia alone, 26 of both the tibia and the fibula, and 17 of the fibula alone—86 in all.

As an introduction to an analysis of these cases, a résumé of the anatomy of the leg may not be inappropriate. According to Davis,² the muscles are divided into four groups (a) The extensor group, including

* Authority to publish granted by Board of Publication, S G O

¹ Col Jos A Blake "Gunshot Fractures of the Extremities," p 92 Masson & Cie, Editeurs, Paris, 1918

² Davis "Applied Anatomy"

the tibialis anterior, extensor longus digitorum, and the extensor longus hallucis, (b) the flexor group, including the tibialis posterior, flexor longus digitorum, and the flexor longus hallucis, (c) abductor group, including the peroneus longus, peroneus brevis, and peroneus tertius, (d) calf muscles, including the gastrocnemius, soleus, and plantaris. The tibia and fibula are connected by (a) the anterior and posterior superior tibio-fibular ligaments, (b) the interosseous membrane, (c) the anterior and posterior interosseous ligaments. The main nerves to be considered are three, the internal popliteal nerve, the anterior tibial nerve, and the musculocutaneous nerve, the two latter being branches of the external popliteal nerve. The internal popliteal nerve supplies the gastrocnemius, soleus, plantaris, and popliteus, and gives rise to the posterior tibial nerve. The latter extends downward in a sheath shared by the posterior vessels, between the superficial and deep muscles of the posterior portion of the leg. The posterior tibial nerve supplies the tibialis posticus, the soleus, the flexor longus hallucis, and the flexor longus digitorum.³ The anterior tibial nerve, which arises from the external popliteal nerve, originates below the head of the fibula in the interval between the peroneus longus and the fibula. After winding externally around the head of the fibula, beneath the peroneus longus, extensor proprius hallucis and the extensor longus digitorum it reaches the anterior aspect of the leg. Lying on the anterior surface of the interosseous membrane, it joins the anterior tibial vessels 8 to 12 cm below its origin and accompanies these vessels down the leg as far as the ankle. It supplies the tibialis anticus, the extensor longus digitorum, the extensor proprius hallucis, and the peroneus tertius. The musculocutaneous nerve continues the course and direction of the external popliteal. Descending through the leg in a fascial tube in the septum between the peroneal muscles and the extensor longus digitorum, it becomes superficial by piercing the deep fascia anterior to the fibula in the lower third of the leg. It supplies the peroneus longus and the peroneus brevis.

There are three main arteries, the anterior tibial, the posterior tibial, and the peroneal arteries. The line of the anterior tibial artery may be taken just internal to the head of the fibula to a point on the front of the ankle midway between the malleoli. The anterior tibial artery pierces the interosseous membrane, but the anterior tibial nerve winds around the head of the fibula and joins the artery 5 to 7 cm or more down its outer side. The line of the posterior tibial artery is from the middle of the popliteal space to the middle of the line joining the internal malleolus and the internal tuberosity of the calcaneus. The peroneal artery is given off from the posterior tibial 2.5 cm below the edge of the popliteus muscle. It follows the inner edge of the fibula beneath or in the fibres of origin of the flexor longus hallucis.

Davis² calls attention to the fact that when the fibula is broken above

³ Piersol "Anatomy"

its lower fourth, there is usually little displacement because the attached muscles hold it in place. In a fracture of the tibia, the displacement of the lower fragment is backward, upward, and slightly outward. It is produced mainly by the muscles of the calf pulling on the tendo calcaneus (Achilles). The upper fragment is pulled forward by the quadriceps femoris.

There are no laws governing gunshot fractures. The types or varie-

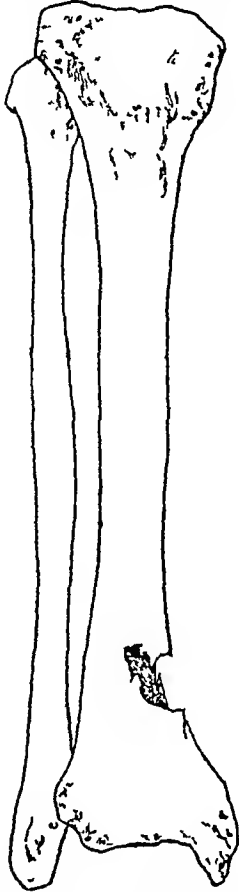


FIG 1 — Incomplete fracture of the tibia, bone wound type deep antero-posterior groove

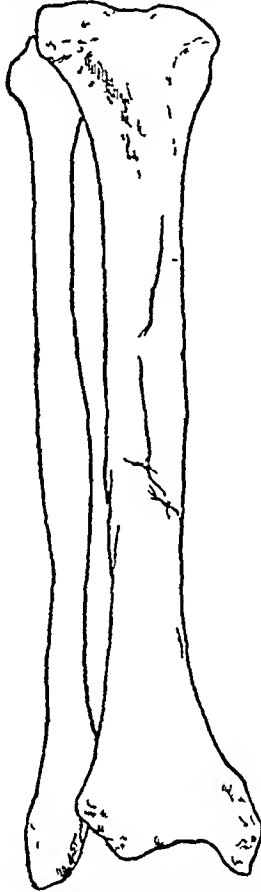


FIG 2 — Incomplete fracture of the tibia illustrating a bone wound at *a*, and extensive fissuring

ties of damage which may be caused to the bone are innumerable. The injuries vary according to the type of missile, its velocity, and its direction in relation to the bones. An excellent general classification is that of Frost,⁴ who, in his excellent paper on compound diaphyseal fractures, divides them into 1 Contusions (lesions essentially periosteal) 2 Incomplete fractures, consisting of (*a*) grooves, (*b*) fissures, (*c*) penetrations, (*d*) perforations 3 Complete fractures.

Considering the tibia and fibula as a group, there is the natural further classification of fractures of both bones and either of the two bones separately. Frost has shown an example in his article of an X-ray

⁴ Frost, Harold *Military Surgeon*, March, 1918



FIG 6 —Complete fracture of the tibia

GUNSHOT FRACTURES OF THE TIBIA AND FIBULA

demonstrating a contusion of bone, but the X-ray in question would be classed by the writer as a "bone wound," a subdivision of incomplete fractures. Moreover, it does not seem possible to admit of contusions being shown in the X-ray, and for the sake of classification, it will be considered that all gunshot lesions of bone that are visible on the X-ray plate must necessarily fall under either incomplete or complete fractures.

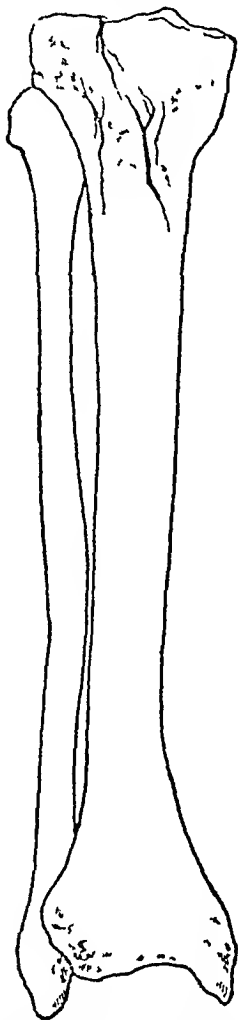


FIG 3 — Incomplete fracture of the tibia, of the fissure type, extending into the knee-joint

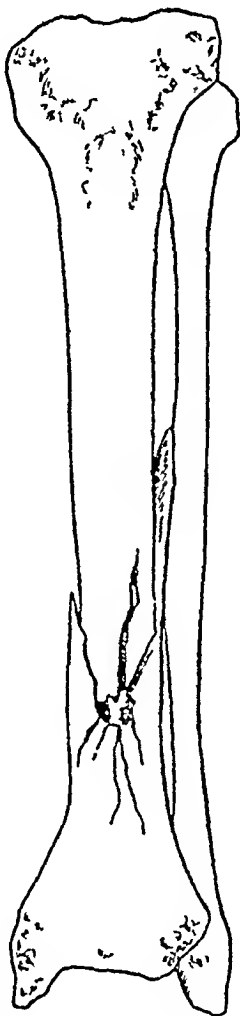


FIG 4 — Complete fracture of the tibia, Perforating type

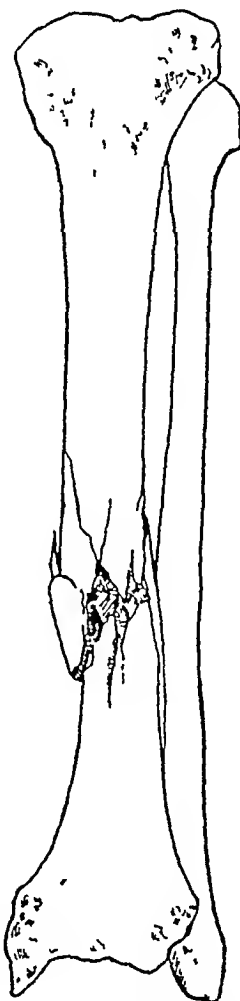


FIG 5 — Complete fracture of the tibia with considerable comminution

Fig 1 shows an example of the "bone wound" type of fracture. It is an incomplete fracture which takes the form of a deep antero-posterior groove. (Case Favier, Theophile, 269th Inf, French Army. Wounded May 23, 1917. Removal of bone fragments on the same day. Admitted to American Red Cross Military Hospital No 2, June 10, 1917, with a circular plaster cast having a window. Discharged October 16, 1917.) Fig 2 illustrates two types of incomplete fracture, as it shows a small bone wound at (a) in the lateral view, and also an extensive fissured fracture, which does not, however, involve the entire shaft and thus cause a complete fracture. (Case Frye, Horace F, Corporal, 6th Marines. Wounded October 7, 1918. Debridement done at front-line hospital. Admitted to American Red Cross Military Hospital No 2 October 9, 1918. The leg was put in a posterior gutter splint and was not suspended. There was beginning union 15 days after wounding and consolidation at 22 days. No traction

Evacuated as Class "C" 43 days after his injury) Fig 3 shows an incomplete fracture of the fissure type which extends into the knee-joint (Case Walsh, William J, Corporal, 307th Inf Wounded September 2, 1918 Diagnosis Gunshot wound of left knee-joint with compound fracture of the head of the left tibia Admitted to American Red Cross Military Hospital No 2 September 6, 1918 Evacuated September 8, 1918) It must be remembered that, as all gunshot fractures are compound, in those which communicate with the knee-joint the latter is almost sure to be involved An incomplete

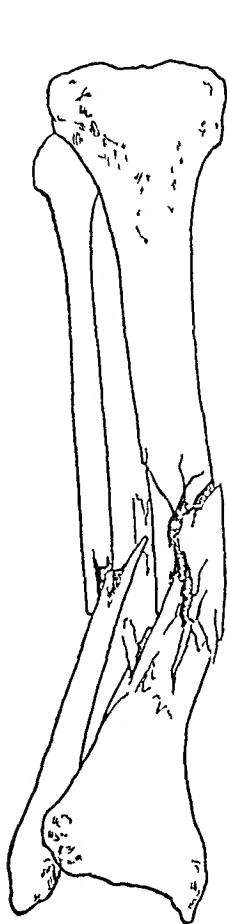


FIG 7 — Complete fracture of the tibia and fibula with comminution

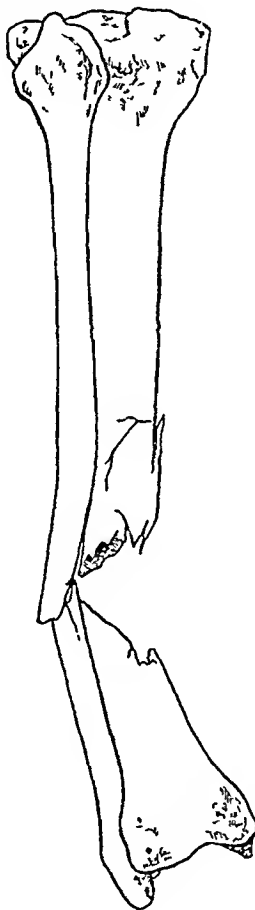


FIG 8 — Complete fracture of tibia and fibula from which the bone fragments have been removed at operation

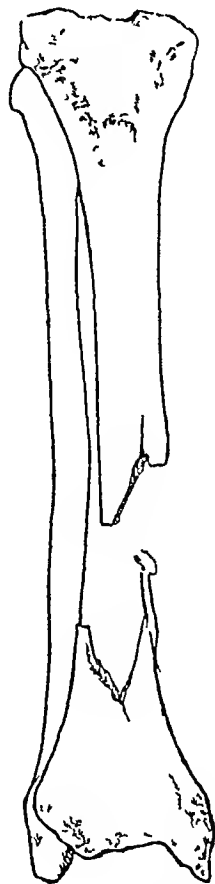


FIG 9 — Complete fracture of the tibia with considerable loss of substance. Drawing made from an X-ray taken three days after operation

fracture of the penetration type has been described as one in which the missile enters the bone but does not leave it. Fig 4 shows a complete fracture of the tibia of the perforating type (Case Parker, Kirke, Corporal, 125th Inf Wounded August 29, 1918 Machine-gun bullet Clean "through and through" wound No operation Suspended in Hodgens splint with traction by Sinclair skate Beginning union 14 days after injury Patient walking with a cane 35 days after injury) Fig 5 is a stage beyond Fig 4 and shows complete fracture of the tibia with considerable comminution (Case Turner, Benjamin R, private, 5th Marines Wounded June 5, 1918 Evacuated July 8, 1918) Fig 6 shows a similar fracture but nearer the head of the tibia (Case Raczynski, Louis, private, 127th Inf Admitted to American Red Cross Military Hospital No 2 on August 8, 1918, from Field Hospital No 127 Evacuated August 9, 1918,

GUNSHOT FRACTURES OF THE TIBIA AND FIBULA

to Base Hospital No 6) Fig 7 shows a typical smashing complete fracture of the tibia and fibula (Case Rettinger, Jonas A, private, 305th Inf Wounded September 4, 1918 Admitted to American Red Cross Military Hospital No 2 September 6, 1918 X-ray and debridement on admission Evacuated September 8, 1918) Fig 8 shows a complete fracture of the tibia and fibula from which the bone fragments have been removed (Case Jarvis, Daniel, private, 11th Inf Wounded October 20, 1918 Debridement and removal of bone fragments at Mobile Hospital No 5 Admitted to Ameri-

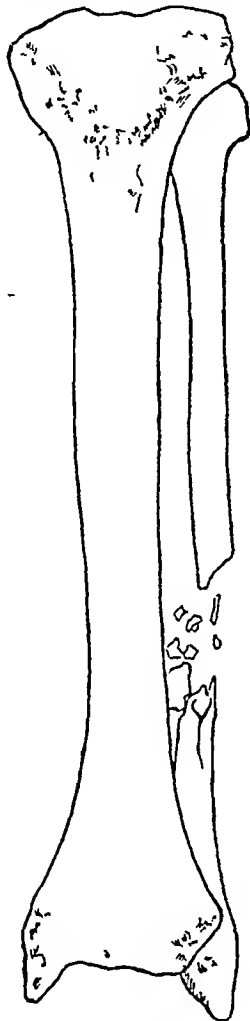


FIG 10 — Complete fracture of the fibula with 4 cm loss of substance This case was not operated upon

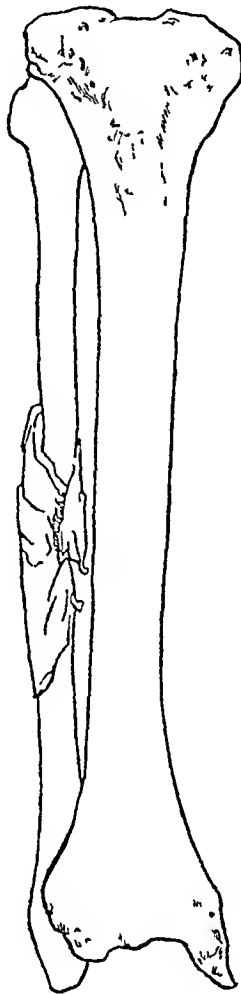


FIG 11 — Complete fracture of the fibula with extensive comminution

can Red Cross Military Hospital No 2 October 27, 1918 Suspended in a Hodgens splint Beginning union 26 days after wounding Evacuated as Class "D" 30 days after injury with very little union and with the wound still discharging) Fig 9 is a good example of a gunshot fracture with extensive loss of substance (Case Palmer, Earl H, 2nd Engineers Wounded June 7, 1918 Admitted to American Red Cross Military Hospital No 2 June 8, 1918 Operation the same day Date of the X-ray from which this drawing was made, June 11, 1918 Evacuated July 19, 1918) Fig 10 shows a gunshot fracture of the fibula with 4 cm loss of substance (Case Bailey, Samuel, private, 311th Inf Wounded October 25, 1918 Admitted to American Red Cross Military Hospital No 2 October 29, 1918 No operation Discharged as Class "D" November 4, 1918) Fig 11 shows a fracture of the fibula with extensive comminution (Case Boyer, Edgar L, 143rd Inf Wounded October 17, 1918 Machine-

gun bullet No operation Admitted to American Red Cross Military Hospital No 5 October 21, 1918, where he remained until November 26, 1918, when he was transferred to American Red Cross Military Hospital No 2 Patient is able to walk with a cane on January 9, 1919) Fig 12 shows a fracture of the fibula with loss of substance (Case Thornton, George, private, 107th Field Artillery Admitted to American Red Cross Military Hospital No 2 on September 1, 1918, from Evacuation Hospital No 4 Discharged September 5, 1918, to Blois) In Fig 13 there is a comminuted fracture of the fibula, upper third (Case Pt Merlog) We have the record of one case of gunshot fracture of both fibulae (Case Powell, Clyde R, private, 109th Inf Wounded September 16, 1918 X-ray examination shows about 3.5 cm loss of substance in both fibulae Wounds practically healed on November 18, 1918) Another case shows fractures of tibiae (Case Cruickshank, Lewis F, private, 125th Inf Admitted to American Red Cross Military Hospital No 2 September 2, 1918, from Evacuation Hospital No 5 Antero-posterior X-ray plates of both tibiae show oblique fractures of the middle third in good position)

Treatment—The principles of first-aid in the gunshot fractures of the tibia and fibula are the same as in those of other fractures The first consideration is the control of hemorrhage, by tourniquet, pressure in or above the wound, or clamping of the vessels, according to the facilities The danger of leaving a tourniquet on too long (a good rule is not longer than half an hour) has so often been demonstrated that it is unnecessary to do more than mention it Of next importance is the immobilization of the fracture This is not a very difficult problem in the case of the tibia and fibula The most satisfactory arrangement is the Thomas splint with traction applied in such a manner as will not unduly constrict the ankle, as a well-padded gaiter, bandaged on, or a double loop or hitch In the absence of a Thomas splint the fractures of the tibia and fibula may very satisfactorily be immobilized in some form of posterior splint, as the posterior wire splint, the tin "gutter" splint, or the wire Cabot splint A long enough splint should be used so that it extends well above the knee-joint A liberal application of iodine in the wound and about its edges, as an antiseptic, seems to be above reproach The first-aid is completed with the addition of a sterile gauze dressing, and a prophylactic injection of tetanus antitoxin

After the first-aid treatment, the patient should be evacuated as rapidly as possible to a field, evacuation, or mobile hospital for operative treatment Before any operation is attempted, it is of the utmost importance that the patient shall have recovered from shock If such is not the case, all efforts should first be made to revive the patient The usual methods of operation on war wounds are applicable to fractures of the tibia and fibula A careful debridement of the wound, with the complete removal of all foreign bodies, pieces of clothing, necrotic and ragged tissues should be practiced Effort should be made to preserve as much as is possible of the periosteum, and bone fragments with periosteal attachment should not be removed The best disposition to make of bone fragments without periosteal attachment is a matter which still permits some debate By the majority of surgeons they are considered as foreign



FIG 12 —Complete fracture of the fibula with loss of substance



FIG. 13 —Complete fracture of the upper third of the fibula with comminution

bodies and accordingly removed. Should the leg already have become infected by the organisms of gas gangrene, a much wider débridement or muscle excision will be necessary or even the amputation of the limb. The débridements must be carefully done with avoidance of injury to the nerves and the larger vessels. It is especially desirable to preserve the posterior tibial artery. The wound is left wide open and lightly packed with dry gauze. The early employment of Dakin solution is to be recommended.

After the patient has arrived at the base hospital or such other hospital where he is liable to remain for some time, measures for the further treatment of the fracture should at once be instituted. For gunshot fractures of both the tibia and fibula, or for the tibia alone, treatment by suspension and traction is the method of choice. In fractures of the fibula alone, immobilization in metal or moulded plaster splints is sufficient. A Balkan frame with the trolley pulley block is the most convenient manner of suspending the splint. Of the latter, several have been employed, *viz*, the Hodgens, the Blake, the full and half ring Thomas. The author prefers the half ring Thomas splint (bent at the knee to about 140 degrees), for by using it in connection with the double pulley system, to be described later, counter traction may be established without the necessity of the inconvenient upper traction rope which crosses the patient's face. The leg is supported in the splint by the well-known bands fastened by clips. Some of these bands may be removed to facilitate the dressing. By adjustment of the bands in accordance with the information given by the portable X-ray machine, the proper antero-posterior alignment may be obtained.

The method of applying the traction must be such as to best fulfill the following conditions: (1) The attachment must be low down on the foot, so as to avoid wounds of the soft parts which may extend down that far. (2) The attachment must be such as not to constrict the foot or ankle. (3) It must not be painful. (4) It must be capable of maintaining such outward rotation, dorsal flexion, and inversion of the foot as is desired. (5) It must not slip or become disarranged while in use. Several devices have been evolved to overcome these obstacles. By far the most satisfactory instrument, in the opinion of the writer, is the "skate" devised by Major M. Sinclair, R. A. M. C. This skate has been described by Colonel Blake and his associate, Captain Bulkley,⁵ as follows: "It consists of a block of wood a little longer than the foot and very slightly wider, in the free edge of which are cut about ten notches. Its centre contains a longitudinal slit through which passes a bolt provided with a thumb nut on the exposed side. The side of the board toward the foot is padded with cotton and covered with gauze. The transverse bar shown in the draw-

⁵ Blake, Col. Jos. A., and Bulkley, Captain Kenneth. "Treatment of Fractures of the Extremities by Means of Suspension and Traction." *Surgery, Gynecology and Obstetrics*, March, 1918.

ing is a piece of iron 5 millimetres thick, 2 centimetres wide, and 15 centimetres long, with a hole at the centre and at each end. With glue 8 or 10 narrow tapes are pasted along each side of the foot, each tape having previously had attached at the end toward the sole a small curtain ring. The bands over the dorsum of the foot do not meet in the midline, but leave a free area to prevent constriction and interference with the circulation. The foot is fastened to the board by lacing the rings on each side to each other on the under surface of the board. The apparatus forms practically a ball-and-socket joint for the control of the position of the foot. The lower free edge of the transverse metal bar rests on the

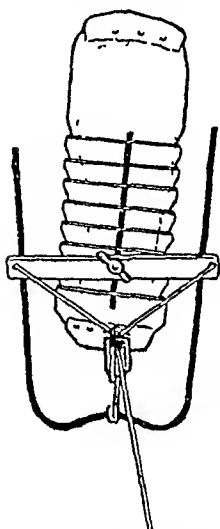


FIG 14—End view of Sinclair skate showing manner of securing outward rotation of the foot by adjustment of the transverse bar

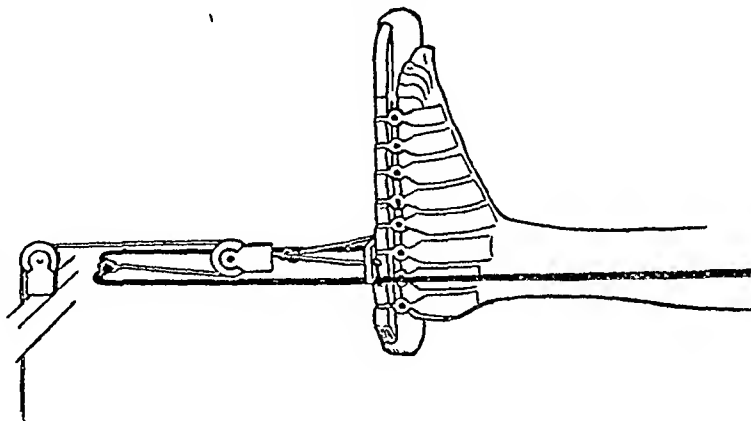
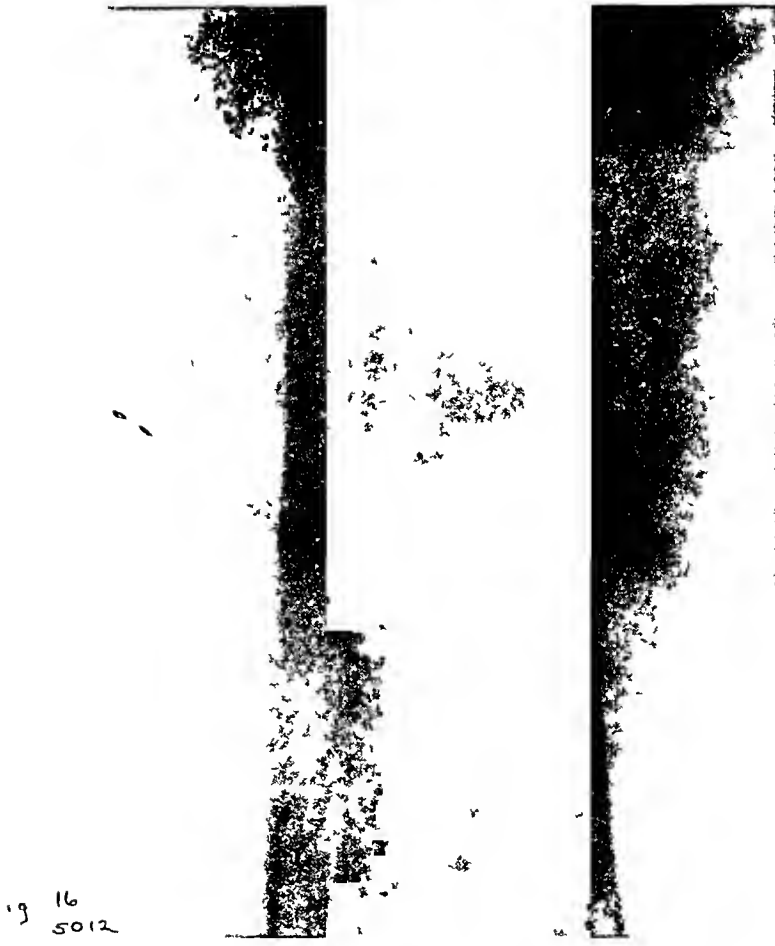


FIG 15—Lateral view of Sinclair skate and pulley showing method of securing proper amount of dorsal flexion of the foot by adjusting the transverse bar further up or down the skate as desired and also showing method of attaching the pulley

parallel bars of the (Hodgens) splint and maintains the position of the foot in the position in which it is placed. To elevate or depress the foot as a whole (correct anterior or posterior angulation at the site of the fracture), the wooden block is slipped upward or downward on the transverse bar, and the thumb screw tightened. To abduct or adduct the toes (rotate the lower fragment inward or outward) the block is rotated on the transverse bar and there fixed. To evert or invert the foot as a whole (correct lateral angulation at the site of fracture) the cord leading from one extremity or the other of the transverse bar is shortened. The 'skate' is especially useful in very low fractures of both bones and in fractures involving the ankle-joint. In Figs 14 and 15 the leading features of the proper application of the Sinclair skate may readily be seen. Fig 14 shows how outward or inward rotation of the foot may be secured by adjustment of the transverse bar, the foot in this figure being shown in the most usual position, that of slight outward rotation. Fig 15 shows the necessity of placing the transverse bar far



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FIG. 16 —Typical example of X-ray of the leg suspended in the splint taken by the portable X ray machine. The outlines of the fracture are readily made out. The Carrel tubes in the wound may easily be identified as well as the side of the splint with the clamps which are used to attach the supporting bands.



FIG. 17 —Same fracture as that shown in Fig. 16 but taken one month later and without the splint. The small foreign bodies were left in place and seemed to exert no deleterious influence on the progress of the healing.



FIG 18 —Complete fracture of the upper third of the tibia showing different stages of callus formation. In *A* is depicted the amount of callus formation at fifty-six days after wounding, and in *B* the callus formation at eighty-four days after wounding. A small sequestrum may be seen on the mesial side in both drawings. This was removed in the course of a dressing.



FIG. 19.—Complete fracture of the tibia and fibula with different stages of callus formation. *A* represents the condition sixty one days after wounding and *B* one hundred fifty one days after wounding. At one hundred fifty five days after operation a sequestrum was removed from the inner border of the tibia and a portion of the fibula around the old injury was removed. Patient was discharged forty one days later that is one hundred and ninety six days after wounding.



FIG 20 —Complete fracture of the fibula showing callus formation



FIG. 21 —Gunshot wound of the left leg with compound fracture of the tibia showing the application of the Delbet ambulatory plaster of Paris splint. It will be noted that the lateral splints are extended below the inferior collar almost to the floor.



FIG 22 —Shortening of the tendo Achillis due to traction which was applied in such a manner that the foot was held in an inadequate degree of dorsal flexion. It will be noted that owing to the shortening of this left tendon it is not possible to touch the left heel to the floor when both heels are abreast.



FIG 23 —Shortening of the left tendo Achillis due to faulty application of traction It will be noted that in order to oppose the entire plantar surface of the foot to the floor it is necessary to advance the foot

enough back toward the heel to secure the proper amount of dorsal flexion of the foot

The kind of glue used in fastening the bands to the foot is a matter of considerable importance. The most satisfactory seems to be that described by Major M Sinclair ⁶

By attaching the pulley to the skate rather than to a cross bar on the frame, and by attaching the end of the rope to the splint rather than to the skate directly, in the manner shown in the figures, it is possible, with a single traction weight at the foot of the bed, to exert a pull on the foot of twice the weight, owing to the mechanical advantage of the pulley, and a pull equal to once the weight on the splint itself and in the opposite direction, that is, forcing the ring of the Thomas splint firmly against the buttock. By this pressure and the pull of the cross bands against the thighs, the requisite counter traction is secured without the disadvantage of a counter traction rope attached to the upper end of the splint and crossing in front of the patient's face to the upper opposite end of the frame.

Another method of applying traction is by means of a garter which laces up the front. The tendency to the formation of pressure sores on the dorsum of the foot and at the tendo Achillis, and the inability to secure the proper position of the foot, obviously are the disadvantages of this method, and moreover, it is necessary to supplement it by a foot suspension. Should it become necessary to employ a garter, it should be well padded underneath and bandaged securely to the foot. Where the wound is high enough on the leg, it may in some cases be possible to secure traction by bands glued to the sides of the calf or by adhesive strips. This method has the same disadvantage of inability to secure the

⁶ Major M Sinclair, R A M C, has supplied us with the following guide as to the preparation and use of the glue

Test for the glue

Place 4 oz of glue in 4 lbs of cold water and leave in a cool place for twelve hours

If	dissolved	bad
If coherent and gelatinous weighing	8 oz	good
If coherent and gelatinous weighing	16 oz	very good
If coherent and gelatinous weighing	20 oz	excellent

The following is the formula

Very good glue	50 parts
Water	50 parts
Glycerine, or glucose calcium chloride	4 or 6 parts
Menthol	1 part

Soak for twelve hours and then melt on a water bath. Neutralize to litmus with sodium hydrate as commercial glue at times contains free hydrochloric acid. Add 4 parts in summer, and 6 parts in winter, of glycerine or glucose calcium chloride and 1 part menthol. Frequent heating evaporates the water, which should be added from time to time. When reheated many times, adhesive power is lost.

Technic (1) The skin is not shaved.
(2) Wash the skin with soap and hot water, which contains about 4 drams of washing soda to the pint, to convert the oil of the skin into soap, as glue will not adhere to a greasy surface.

(3) Dry the skin.
(4) Apply the warm glue evenly, brushing all the hairs of the limb in an upward direction.
(5) Keep a tension on the gauze all the time. Bring it quickly but carefully into contact with the limb (inner and outer surface), and apply a neatly and loosely woven bandage starting a hands-breadth above the malleoli up to the knee joint (in case of fracture of the femur).

(6) When dry apply traction.
NOTE—The adhesive can be made waterproof with a 2 per cent solution of potassium bichromate applied in the dark and then exposed to the light, or by means of formalin.

(7) The extension must always be very carefully applied, whether with Maw's elastic cotton net or with gauze.

(8) The extension must be changed at once if the patient complains of a tickling or burning sensation under it but it generally requires changing about the tenth, twentieth, and fortieth days.

proper position of the foot. A fourth method, the Finochetto's band, seems to be even less advisable. In this method the traction is secured by means of a thin metal band which is passed above the os calcis and behind the tendo Achillis. The chief advantage of this arrangement is the readiness with which dorsal flexion is secured. But it possesses no advantages which are not possessed by the Sinclair skate, and in addition it exposes the patient to the risk of another portal of infection.

The amount of traction to be used is determined by the position of the fragments as shown in the X-ray. Fig. 16 shows a typical portable X-ray of the leg in a splint with Carrel tubes in the wound. Fig. 17 shows the same leg one month later. It is well to start with about 12 pounds in fractures of both bones and to reduce this amount as reduction of the fracture is effected. A smaller amount of weight is required when only the tibia is fractured. When the double pulley system of traction is employed, a weight equal to one-half the desired pull is used.

The position of the fragments is further altered and corrected by appropriate manipulation of the supporting bands of the splint. For posterior sagging in the fracture the bands in this region are tightened, for anterior bowing they are loosened. If traction alone does not secure the desired alignment, the bands on one side of the fracture may be tightened and those on the other side of the fracture may be loosened, as necessary. To facilitate access to the wound in dressing it, that band which is opposite the wound is removed. If there is a tendency to sagging at the fracture at the time the dressing is done because of the removal of the band, a small sterile band may previously have been placed next to the wound, which band is kept loose except at the times of the dressings, when it supports the fracture. Where the wound is large and there is considerable discharge, the best material of which to construct the bands is a rubberized fabric which is non-elastic, waterproof, and may readily be cleaned. Such bands may contain perforations and are best fastened to the splint by means of metal spring clips. Where it is unnecessary to change the bands frequently, flannel ones may be used and these are best fastened to the splint by safety pins. A convenient arrangement is to make the band long enough to reach from one side of the splint to the other and back again, in which case it will be necessary to fasten it only on one side.

The treatment of the soft parts is in itself a very wide field and one meriting the most careful consideration and study. Even assuming that the wound has been properly and thoroughly debrided at the time of the operation, it is necessary to be constantly on watch for the formation of pus pockets. With the foot held at right angles to the axis of the leg, as is the best position, a slight tension is exerted on the tendo Achillis and from there in turn upon the gastrocnemius and the soleus. A drainage tract that passes between the fibres of these muscles seems to be especially liable to have its sides approximate and cut off the exit for the pus.

GUNSHOT FRACTURES OF THE TIBIA AND FIBULA

Leaving a wide rubber drainage tube in such a tract for longer than forty-eight hours invites the danger of eroding a vessel wall and causing a severe hemorrhage. It may be necessary from time to time to enlarge the narrowing orifice of the tract by spreading a clamp in it. In all deep sinuses which have a tendency to pocket, it is most advisable to irrigate it daily with warm saline solution by means of a catheter attached to an irrigating can.

Irrigation of the wound by Dakin's fluid by the method of Carrel has produced very good results. Even where no secondary suture is contemplated, this method of treatment cleans up the wound very quickly. The muscle tissue takes on the well-known bright red appearance, and all particles of necrotic tissue disappear. As long as there is bone presenting in the wound it seems inadvisable to attempt a secondary suture even though the bacteriological reports are satisfactory. When the wounds become shallow and are cleanly granulating, the success attendant upon drawing the skin edges together by means of adhesive straps is very remarkable. Wounds 5 by 12 cm or smaller are far more simply treated by this method and with less inconvenience to the patient and with less trouble to the surgeon.

There are no set rules for the length of time that the leg is to be suspended. In general, it may be said that the leg should not be taken down until the union is firm. In cases where it is particularly desirable to get the patient up and around in a wheel chair, a properly shaped and padded posterior wire splint may be put on even if the union is not quite stiff enough to warrant discarding all splints. The methods of testing the extent of union are two, manipulation and the X-ray. In the former, the leg must be lifted free of the splint, and grasped on either side of the fracture. By gentle motion it is endeavored then to find out how much, if any, motion there is at the site of the fracture, how readily this motion may be elicited, and how painful it is. A very simple test is to grasp the leg by the ankle and gently lift it out of the splint. Examinations made by the portable X-ray machine, or better, stereoscopic X-ray plates, will give a very good conception of the extent of callus formation, but in a last analysis, the best test for the strength of the leg is the clinical one.

Figs 18 and 19 are reproductions of drawings made from X-ray plates and show the progress of callus formation during one month (Rice) and three months (Cathery), respectively. (Cases Fig 18 Rice, Willard, private, 23rd Inf. Admitted to American Red Cross Military Hospital No 2 on November 26, 1918, 54 days after wounding. Complete fracture of upper third of right tibia. In "A" is depicted the amount of callus formation in the fracture at 56 days after wounding, and in "B" the callus at 84 days after wounding. A small sequestrum may be seen on the mesial side in both drawings. This was removed in the course of a dressing. Patient evacuated January 10, 1919. Fig 19 Cathery, Antoine, 215 Reg d'Inf 15 Cie, French Army. The patient was wounded on August 16, 1917, and admitted to American Red Cross Military Hospital No 2 on September 10, 1917. On admission a tube was found inserted antero-posteriorly through the lateral aspect of the lower left leg just above the joint. X-ray examination at this time showed a comminuted fracture of the tibia and fibula with

FREDERICK CHRISTOPHER

several loose fragments in the soft tissues on the external aspect The leg was suspended in a Hodgens splint and traction was applied by a Sinclair skate There was beginning union in the fracture 37 days after wounding and consolidation at 57 days Following this the convalescence was somewhat prolonged At 64 days the leg was put in a plaster cast and at 87 days the cast was removed and the patient instructed to walk without support At 94 days after the injury all wounds were healed, save for a scab At 97 and 135 days sequestrectomies were done On January 18, 1918, one sequestrum was removed from the inner border of the tibia and also a portion of the fibula about the old injury (Col Blake) The patient was discharged on February 28, 1918, 196 days after wounding "A" represents the condition 61 days after wounding and "B" 151 days after wounding) Fig 20 is an illustration of callus formation in a fracture of the fibula (Case Lynch, Donald B, mechanic, 168th Inf Admitted to American Red Cross Military Hospital No 2 on November 26, 1918, from American Red Cross Military Hospital No 5 Evacuated January 10, 1919)

Naturally, the time for repair depends entirely upon the extent of bone injury A "through and through" machine-gun bullet wound in which the bone is merely fissured, and in which it is unnecessary to perform a debridement, will unite very quickly On the other hand, where there is extensive loss of substance, and a large suppurating wound, the time required may be very great Tables A and B well illustrate this variation in time They also demonstrate the difficulty there has been to obtain consistent and complete records It is of interest to note in Table A that the average length of time after wounding before the cases

TABLE A
18 SELECTED CASES OF GUNSHOT FRACTURES OF THE TIBIA
(Cases in which the records were the most complete)

Days after injury received at A R C M H No 2	Type of splint on arrival	Type of splint used for suspension	Type of traction	Beginning union at (days)	Consolidation (days)	No days treated at A R C M H No 2
1	Gutter	Hodgens	Skate	14	35	35
8		Hodgens	Strips to leg			55
2	1/2r Thomas	Hodgens	Boot			26
3	Posterior wire	Posterior splint				37
2	Wire	Hodgens				22
2	Wire	Thomas	Skate			38
2	Wire	Hodgens		15		20
1	Gutter	Hodgens	Skate		43	68
7	Posterior wire	Hodgens		25		30
1	Gutter	Hodgens				38
3	Posterior wire	Hodgens		23		24
3	Posterior wire	Hodgens		16	23	31
2		Hodgens				50
4	1/2r Thomas	Thomas	Skate	31		59
1	Wire	Hodgens				41
3	Wire	Hodgens	Skate	45		69
3			Skate			50
2	Posterior wire	Posterior gutter		15	22	43
Av 27						

GUNSHOT FRACTURES OF THE TIBIA AND FIBULA

TABLE B

14 SELECTED CASES OF GUNSHOT FRACTURES OF THE TIBIA AND FIBULA (BOTH BONES)
(Cases in which the records were the most complete)

Days after injury received at A R C M H No 2	Type of splint on arrival	Type of splint used for suspension	Type of traction	Beginning union at (days)	Consolidation (days)	No days treated at A R C M H No 2
4	Thomas	Thomas	Skate			31
5	Thomas	Hodgens		36		36
6	Thomas			30	52	59
5	Thomas	Blake				20
4	Thomas	Hodgens	Skate			23
3		Hodgens	Anklet			71
2		Blake	Skate	48		72
4	Wire	Hodgens	Skate			22
3	Thomas	Hodgens	Skate			30
6	Thomas	1/2r Thomas	Skate			26
3	Thomas	1/2r Thomas	Skate			18
4	Thomas	Thomas	Skate			17
7	Thomas	Hodgens	Strips to leg			51
4	Thomas	Hodgens	Boot	50		67
Av 4 2						

in this series were received at American Red Cross Military Hospital No 2 was 27 days, with variations from one to eight In Table B, of fractures of both bones of the leg, the corresponding average was 42 days The table also shows that the Hodgens was the splint most frequently used for suspension, and that the Sinclair skate was the device most frequently employed in the application of traction

After there is firm fibrous union in the fracture, consolidation may be hastened by the application of the moulded plaster splint of Delbet Some skill is prerequisite to the putting on of these splints The essential feature of their construction lies in two lateral splint bridges which connect firm collars just above the malleoli and below the tuberosity of the tibia and the head of the fibula These collars must be snugly approximated to the skin, which previously has been protected with vaseline With a successful splint of this type the patient may walk without pain or injury at the site of the fracture, for the weight of the body is transmitted directly from the malleoli to the head of the tibia and fibula by means of the lateral splints The very small amount of weight that is put on the fracture seems to accelerate the new bone formation With this type of splint it is important that the leg be carefully observed for symptoms of pressure on the anterior tibial nerve at the head of the fibula (foot drop) Fig 21 illustrates a Delbet splint

Motion in the joints should be initiated as soon as possible With most of the devices in which the traction is applied to the foot, it is not possible to get a great amount of motion at the ankle-joint while there is traction on the leg As soon as there is union, passive, and, particularly, active motion, and massage must be started at once Gunshot frac-

tures of the tibia and fibula are far less difficult to treat than those of the femur, and the results are generally excellent. However, it is important to bear in mind during the treatment that a cause of functional disability is the failure to preserve the proper axis for weight bearing and the lateral tilting of the ankle.⁷ As soon as there is consolidation, it is important to get the patient out of bed and up in a wheel chair or walking on crutches. He should be encouraged to eat heartily and to be out of doors as much as possible.

Complications and Sequelæ—Of first importance as a complication of gunshot fractures of the tibia and fibula must be placed gas gangrene. Practically all the war wounds are contaminated with the organisms of gas gangrene at the time of the injury. Gas gangrene may develop in cases where there has been too great a delay between the wounding and the operation, and in cases where the original débridement was inadequately performed. However, a wound that has been properly debrided may be so tightly bandaged that there is insufficient opportunity for gas drainage from the tissues adjacent to it. In such a contingency, a case of clinical gas gangrene may develop which otherwise would never have appeared. We should be on guard for the development of gas gangrene not only in cases which have not already been operated upon, but also in wounds that have been operated. While a fully developed case of gas gangrene presents a very typical picture, the *early* diagnosis of this infection is by no means easy. The factors of chief importance are the history of a recent wound, swelling of the leg, tympanitic note on percussion of the leg, the increase in the pulse rate, the odor of the wound, the maintained intelligence of the patient, the tense elastic resistance of the leg on palpation, and occasionally the X-ray plate.⁸

The most successful treatment of gas gangrene is surgical and varies according to the extent of the involvement. With circumscribed and local infections, a muscle debridement or excision may suffice. Where the gas has ruptured the muscle sheaths and has spread throughout the limb, the only hope lies in immediate amputation. The therapeutic use of serums has not given encouraging results with us, though it must be admitted that it was often not tried until surgical measures were despaired of.

Sequestra are one of the most common complications of gunshot fractures of the tibia and fibula, and they arise either from fragments of bone that were not removed at the original operation, and have died owing to their isolation from blood supply, or from ends of bone that have died because of the impairment or removal of their supply of nutrition. The diagnosis of sequestra is most accurately made by means of stereoscopic X-ray plates. In these, the fragment of dead bone is conspicuous by the denser shadow which it casts (see Fig 18, inner margin).

⁷ Dachtler, H. W. *American Journal of Röntgenology*, October, 1918.

⁸ Christopher, Frederick. "The Early Diagnosis of Gas Gangrene." *Journal of the American Medical Association*, February 8, 1918.

GUNSHOT FRACTURES OF THE TIBIA AND FIBULA

The stereoscopic effect gives us very definite information as to whether the sequestrum is anterior or posterior. Other evidence as to the existence of sequestra are persistent discharging sinuses, or delayed union. Not infrequently a sequestrum is found during a dressing and may be removed by a hæmostat. It may be added that in such a case it is advisable to give as a routine 1000 units of tetanus antitoxin (*vide* Government memorandum). Generally the removal of sequestra requires a general anæsthetic and an operative enlargement of the wound so that the fracture and the sequestrum are in full view before an attempt is made to remove the latter. A sequestrectomy may prove to be a very difficult and tedious operation, and great care should be exercised in the performance of it. Occasionally the bone may be refractured in the course of such an operation, and in such cases of fracture of the callus, the rapidity with which union recurs is surprising.

The knee-joint may be involved by progressive infection from wounds adjacent to it. Or it may be involved directly in the cases of fissured fractures which enter into the capsule (see Fig 3). Or again, the knee-joint may accidentally become infected through operative procedures. In all cases knee-joint infections, especially those due to the hæmolytic streptococcus, are most unwelcome and dangerous sequelæ. Sufficient drainage of such a joint may exist through the communication to the wound, but frequently it is necessary to make lateral slits in the capsule for further drainage, and, in extreme cases, amputation at or above the knee-joint must be resorted to.

Abscesses of bone (an abscess of bone is shown in Fig 18) and muscle are generally not alarming complications and readily may be diagnosed and treated. Gently exploring the recesses of the wound with a Kelly clamp will often locate pus pockets which have been suspected owing to a rise in the temperature curve.

Delayed union and non-union are not very frequent complications in the gunshot fractures of the tibia and fibula. These may be due to sequestrum formation, in which case the remedy is the operative removal of the sequestrum or sequestra, they may be due to foreign bodies, where, as in the case of sequestra, the treatment is the removal; they may be due to the interposition of muscle between the fragments, where surgical treatment again becomes necessary. Extensive loss of substance is often difficult to cope with and it requires long continued treatment to bridge the gap by new bone formation. Generally speaking, it is unwise to attempt bone grafts or bone splints until the wounds have completely healed. However, it may be said that a septic field is not positive assurance of the failure of a healthy bone transplant. Osteomyelitis is an infrequent, but may be a very serious complication. Its treatment is the operative removal of the infected bone, and, in the more serious cases, amputation. It seems to occur less frequently in the tibia and fibula than in the femur. Faulty position is generally the result of

the neglect of the points of treatment outlined above, but in the event of its occurrence to such an extent as to cause functional disability, refracture is occasionally advisable

Plantar flexion is a very annoying and inexcusable complication. It is caused by fixation of the foot in the splint in insufficient dorsal flexion, which causes a temporary shortening of the tendo Achillis and the muscles attached to it. When the patient is able to bear his weight on the fracture, he finds that, with the leg straight down, the ball of the foot only touches the floor (see Figs 22 and 23, Pvt N Bosson, French Army, FCC Tibia, seventy-fourth day), and efforts to press the heel down to the floor are quite painful. The treatment of this condition is massage and persistent employment of exercises which tend to stretch the tendo Achillis and its attached muscles. At the time of the original injury or at a succeeding operation, one of the main nerve trunks may have been injured, which one being readily ascertained by a study of the type of paralysis. If the motor function is not improved or recovered by three or four months after the injury, and the wound is entirely healed, a neurorrhaphy is indicated. Stiff joints, except those due to infection, are generally of very temporary duration and most always yield quickly to massage. The presence of blisters is to be suspected when the patient complains of a tickling or burning sensation under the glued straps. The skin should at once be inspected in such a case, and in the event of blisters being present, another type of traction should temporarily be substituted.

The writer wishes to express his thanks to Colonel Joseph A. Blake, M C, Chief Consultant in Surgery for the District of Paris, whose teachings have furnished the material for this paper, to Major Kenneth Taylor, M C, Commanding American Red Cross Military Hospital No 2, for his helpful criticism, and to Sergeant John J. Owens, of Museum Unit No 1, Army Medical Museum, whose drawings, which are reconstructions made from X-ray plates, have furnished most of the illustrations for this paper. The original drawings made by Sergeant Owens are on file at the Army Medical Museum, Washington, D C, and it is through the courtesy of the Museum that reproductions of these drawings are used.

THE RAPID CLOSURE OF SURGICAL WOUNDS, SPECIALLY OF LAPAROTOMIES

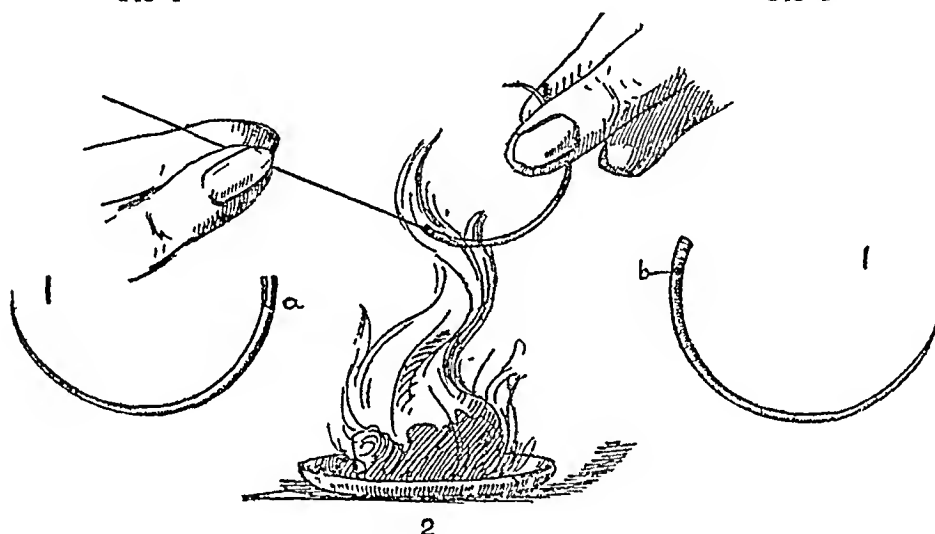
BY ANGELO L SORESI, M D
OF NEW YORK, N Y

THE rapid closure of surgical wounds, and specially of laparotomies, is performed with silver or bronze wire soldered on special needles, and kept in place by lead shots on both ends

The instruments to be used and the *modus operandi* are the following We use a special needle described in the *Revue de Chirurgie*, March-April, 1917, A L Soresi *Aiguille modifié pour la suture avec fils métalliques*

FIG 1

FIG 2



FIGS 1 AND 2 —Needles with a slot (a) and a tube (b) in place instead of the ordinary eye 2 shows the easy manner of soldering wire to needle, any flame will do

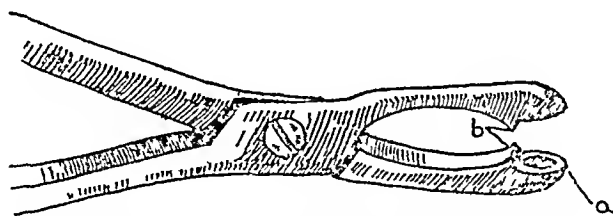


FIG 3 —Special forceps showing (a) depression in which the shot is secured, a similar depression is found in the other jaw of the forceps (b) cutting edges

This needle, as shown in Fig 1, has no eye, but instead ends with a small tube or a slit, in the tube or in the slit is put a little of any one of the quick solders on the market and the wire is inserted in it, the whole is then put on any flame, such as one obtained with a piece of cotton soaked with alcohol (Fig 2), and heated, the wire becomes immediately soldered to the needle, and, if there is any excess of the solder sticking out, it is easily scraped away, so as to make the whole needle perfectly smooth

FIG 4

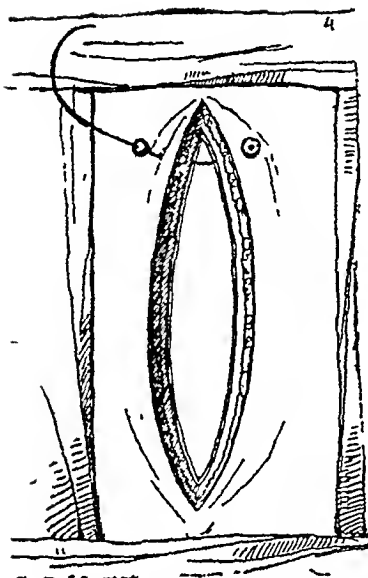
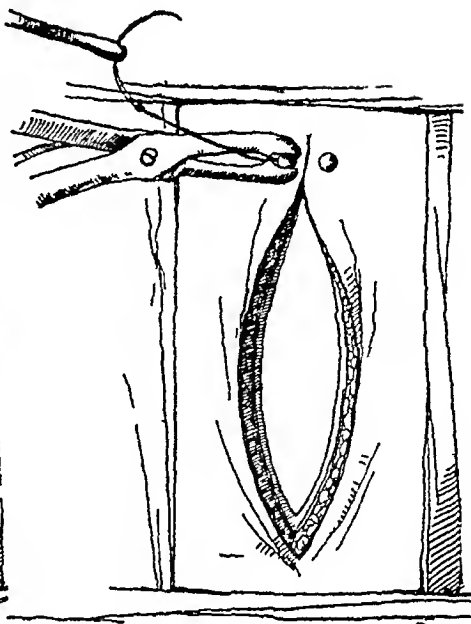


FIG 5



FIGS 4 AND 5 — Showing how wires and shot are applied

FIG 6

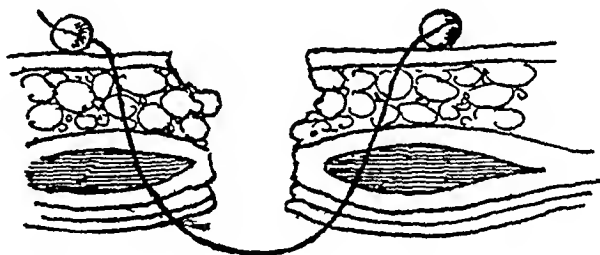
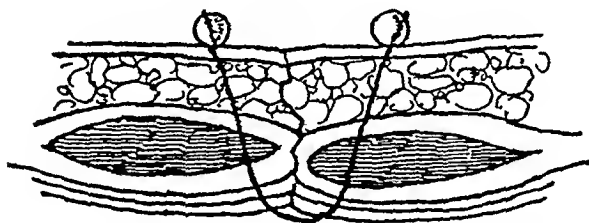


FIG 7



FIGS 6 AND 7 — Schematic view of how wire penetrates (Fig 6) and then (Fig 7) approximates the tissues when wires are pulled taut and shots are squeezed

CLOSURE OF LAPAROTOMY WOUNDS

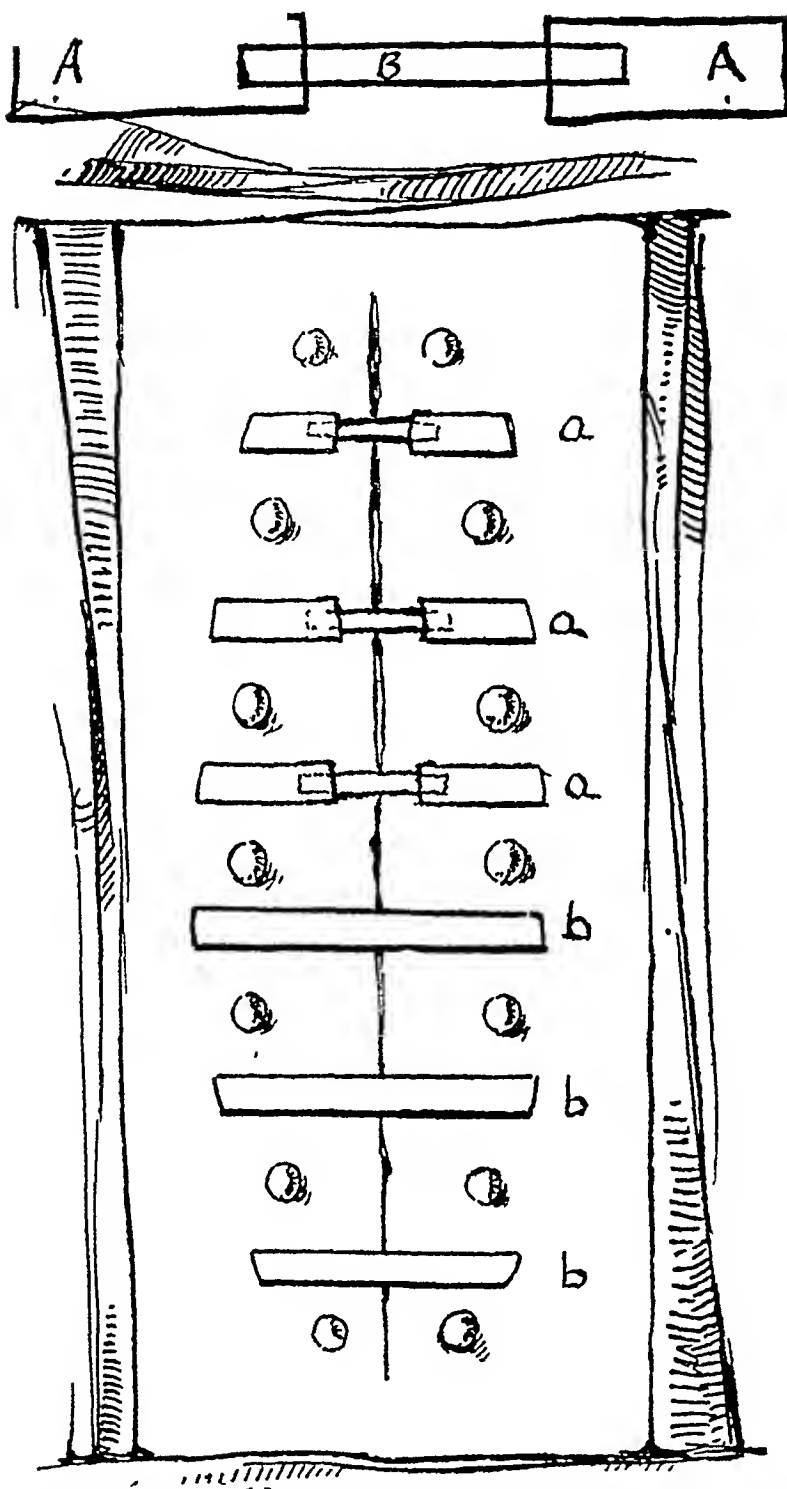


FIG 8 —Showing how skin can be approximated with plain adhesive strips or with elastic strips, elastic strips are ideal and close the skin better than sutures and can be easily prepared by cutting two strips of adhesive 4 A, to these two strips of adhesive a piece of rubber band is attached by simply pressing the rubber band B, against the rubber of the adhesive The elastic strip so prepared is applied to the skin

We use a wire about twenty centimetres long, which serves for two stitches. The piece of wire that is left in the needle is easily removed by heating again the end of the needle and pulling out the wire when the solder has melted. The advantage of this needle is that the wire is not bent on itself, as it is in the ordinary needles, the bend making it difficult to pass the wire through the tissues, while the wire soldered on the needle, that we have described, passes through the tissues as easily as the needle itself. A sufficient number of such needles are prepared and kept ready for use, they are sterilized by boiling them with the other instruments.

The other instrument is a special forceps, that will squeeze the shot and at the same time cut the wire. The instrument, as shown in Fig 3, ends with two jaws which have a round depression on their middle and behind the depression there are two strong cutting edges. The shot, with the wire through it, is put in one of the depressions of the jaws of the instrument, the two jaws are firmly closed, and in doing so the shot will be tightly squeezed and hold the wire, which will be cut by the cutting edges, when and only after, the shot has been squeezed and has firmly secured the wire. The wire cannot be cut before being snugly secured in the shot, because the two cutting edges cannot cut until the shot has been squeezed, because until then they do not come in contact.

The *modus operandi* is the following:

The nurse prepares the necessary number of wires, one end of which is already secured over a shot and the other is soldered to the needle. When the surgeon is ready to start the suture, the nurse hands him the wire, prepared as we have said, and the surgeon perforates with the needle the tissues that are going to be sutured (Figs 4 and 5), pulls on the wire, so that the shot comes in contact with the skin, introduces another shot through the needle, catches the shot with the special forceps and, pulling on the wire, while he brings the shot in contact with the skin, so as to give the suture the necessary tension, squeezes the forceps. In rapid succession the nurse hands one wire after the other until the suture is finished. The closure of the abdomen with the method described has been found very useful and satisfactory in the continuous emergency work during the war and can be successfully applied in civil surgery alone in extremely urgent cases, or as a reinforcing suture of the abdomen and other organs, which are closed with the ordinary method. It is obvious that in the cases in which this method of closure is applied as reinforcing means, the last shot should be squeezed and the wire pulled taut and cut only after the other plans of sutures have been duly tied. The edges of the skin come in close contact spontaneously when this method is used, but if a most perfect approximation is desired, it can be obtained either with a few stitches or by applying strips of adhesive plaster as shown in Fig 8, which give a scar almost invisible.

A L SORESI, M D

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting held October 8, 1919

The President, DR WILLIAM A DOWNES, in the chair

GIANT-CELL SARCOMA OF THE TIBIA, EIGHT YEARS AFTER OPERATION

DR FRANK MATHEWS presented a patient who was shown to the Society some years ago, and was now shown again because the condition had a definite bearing upon the paper of the evening

Eight years ago this patient came to Doctor Mathews suffering from giant-cell sarcoma of the outer tuberosity of the tibia. During the operation of cutting down and sciaping out the tumor he opened the knee-joint. It was impossible to close the cavity in the outer tuberosity and therefore the whole wound was packed with iodoform gauze. There was later an infection in the knee-joint, this was opened and resulted in a stiff knee. Doctor Mathews then lost track of the case, the patient coming under his observation again only a few weeks ago, at which time he had stereoscopic pictures taken of the leg in order to see what had taken place during the interval. The plate, which was shown to the Society, showed a definite cavity with no bone filling, there was a ring of the tuberosity still preserved, this was the result in a case eight years after removal of a giant-cell sarcoma, in which healing had been prompt.

DR FREDERIC KAMMERER mentioned two cases of giant-cell tumor of the internal condyle of the femur that had come under his observation during the past six months. They were both operated on by thorough removal of the masses within the condyle and subsequent cauterization with concentrated carbolic acid and alcohol, as recommended by Bloodgood. In the first instance a curettement only was done six months ago, but this was followed three or four weeks later by another curettement and cauterization with concentrated carbolic acid. In the second the combined procedure was instituted at the first operation. The earlier case was practically healed. In the second case, where the tumor masses had invaded the soft parts through an opening in the condyle made at a previous operation, the bone cavity and the soft parts presented the appearance of healthy granulation tissue. Of course, it was too early to speak of any definite results in these two cases.

DR WILLIAM B COLEY stated that this case brought up the important question of the proper treatment of tumors of the long bones, and called attention to his own conservative methods in dealing with long-bone

sarcomas He said that he now had 16 cases well over three years in which he followed the conservative treatment Of 40 tibia cases which he has had, only 3 were of the giant-cell variety Stress was laid upon the great disparity of opinion among various pathologists regarding this diagnosis, stating that Platou, of Christiana, in the *ANNALS OF SURGERY* (March, 1918) had published an article in which he stated that it was practically impossible from microscopic examination alone to diagnose this condition

Doctor Coley referred to a case of sarcoma involving 5 inches of the upper end of the tibia shown before the Society sometime last year, which was at first diagnosed as giant-cell sarcoma, but was found also to contain a number of spindle cells, in this case there was only a thin layer of cartilage shutting off the knee-joint The knee-joint was curetted and patient placed on mixed toxins, there was a recurrence necessitating further curettement, there was still another, and quite rapid recurrence, and at this time radium treatment was given A recent X-ray picture shows reformation of bone In a second case of giant-cell sarcoma of the lower end of the tibia, curettement was followed three times by a recurrence, at which juncture Doctor Coley placed the patient upon the toxins and X-ray treatment, this patient is now well fourteen years later, with a good leg Another patient with a sarcoma of the tibia, spindle-cell, periosteal, with metastases in the groin, is now well after two and a half years Doctor Coley voiced the belief that simple periosteal growths could be let alone, but that the patient is given a better chance if to curettement and cauterization with concentrated carbolic acid and alcohol is added treatment with the toxins and radium

FRACTURE OF THE SKULL WITH CEREBRAL HERNIA

DR FREDERICK T VAN BEUREN, JR, presented a boy aged twelve years, who came into Roosevelt Hospital last April, about six months ago, after having collided with an automobile truck He was unconscious on admission and showed a lacerated wound in the left frontal region with a depressed fracture of the skull and a protrusion of cerebral tissue As he was only semi-conscious at the time of operation local anæsthesia was employed without discomfort, the incision enlarged and several bone fragments removed, protruding brain excised and edges of wound débrided There resulted a defect in the skull of about 9 cm long and 5 cm wide The fracture ran down into the frontal sinus, and there was also a fracture of the nasal bones and a severe wound of the chin The scalp wound was sutured and drained, it healed nicely except at the middle, where an infection occurred and where there followed a cerebral hernia pulsating and sloughing for about four weeks The infection apparently came through the frontal sinus from an abscess which formed in the region of the nasal duct Six weeks after the injury the patient was able to leave the hospital, the wound being practically healed Since this time

SUPPURATIVE OSTEOMYELITIS WITH FAT IMPLANTATION

he has made no complaint of headaches and has shown no other symptoms of trouble His wound is firmly healed There remains the defect in his skull, now measuring about 6 cm by 3 cm

OSTEOSARCOMA OF TIBIA

DR WALTON MARTIN presented a boy of nineteen years, who was admitted to St Luke's Hospital on June 9, 1919, with the history that in December, 1918, he had pain in the right knee, throbbing in character, intermittent and increased on walking In April he noticed a swelling just below the knee and to the outer side Pain gradually increased and he lost 38 pounds in weight An X-ray picture showed a very large cavity in the head of the tibia The growth, which proved to be a giant-cell sarcoma, was curetted out on July 16, the cavity has now decreased about one-half After the operation the patient was transferred to the General Memorial Hospital where he received treatment with radium Doctor Martin stated as his belief that the cavity in the tibia in this patient would present practically the same appearance in a year's time as the patient shown by Doctor Mathews

SUPPURATIVE OSTEOMYELITIS WITH FAT IMPLANTATION

DR WALTON MARTIN presented a man who had sustained a gunshot wound of the shoulder, the humerus being struck by a fragment of shrapnel He originally presented a large cavity with sequestra Ten sequestra were removed and the outer wall of the cavity taken away The effort to crowd in the soft parts, however, was not satisfactory, as a considerable dead space was left on bringing them together Therefore a piece of subcutaneous fat was removed from the abdominal wall and the plug of fat inserted into the bone cavity The wound was closed by interrupted sutures The lower part of this wound closed, but the upper part opened after the removal of the sutures on the eighth day, and the fat was then exposed It gradually turned whitish and gave the appearance of a white slough with little globules of oil on the surface Finally this slough came away and the wound healed

Doctor Walton also presented a man who, in 1913, fell over a cliff, sustaining a compound fracture of the leg which became infected, from time to time sequestra were discharged From 1913 to 1917 it was a continual round of healing and reopening of the wound, with removal of sequestra He had five operations during this period Doctor Martin first saw him in December, 1917, when an incision was made over the old cavity, a small sequestrum removed, and the walls of a tunnel extending through the tibia were chiselled away until sound bone was reached on all sides The leg was then subjected to the Carrel-Dakin treatment for three weeks until smears showed only one staphylococcus to a field A plug of fat taken from the abdominal wall was then placed in the tunnel of bone The skin was so tense and bound down to the underlying tissue

from previous operations that it did not glide over the bone easily and was only brought together by interrupted sutures with difficulty, portions of the fat projecting between the interrupted sutures. The leg was then put up in plaster. There was no rise in temperature after the operation. After ten days the dressing was taken down, there were crusts over the fat projecting between the sutures where the blood had dried. The stitches were removed and another cast was applied. One week later the patient went south. On his return, after three weeks, the plaster was removed and the wound had healed soundly. At the present time the skin over the site of the wound was found to be freely movable and there was no pain or other discomfort. The leg has been healed for nearly two years.

Doctor Walton also presented a patient who was admitted, in 1916, to St. Luke's Hospital with osteomyelitis of the femur, with a secondary abscess in the popliteal space and an abscess to the outer side of the thigh. The wound was opened, the outer portion of a cavity in the femur dissected away, sequestra removed and the abscess in the popliteal space drained and filled with "bipp". The wound had healed by two folds of soft tissue turning in against the bone, leaving a deep gutter in the thigh. The knee-joint was stiff and bent at a right angle, it was now freely movable. The wound has been healed since November, 1918.

Doctor Walton also presented a woman of fifty-six years, who was admitted to St. Luke's Hospital fifty-four years ago at the age of fourteen months, with a suppurative condition of both arm and leg. Doctor Buck operated upon her at that time, making several incisions. The arm healed satisfactorily, but the leg continued to bother her from time to time. Twelve years ago she came to Doctor Martin with a chronic osteomyelitis of the tibia, he exposed the tibia, removed all the dead bone, but made no careful effort to approximate the soft parts. Seven years ago, five years after his first operation, she returned because of intolerable pain. He then performed an extensive operation, removing a considerable portion of the upper part of the tibia, that is, the outer wall of the bone cavity, and crowded in the soft parts. She developed a secondary abscess in the soft parts after the operation. This was opened and drained. The leg then healed and has remained soundly healed. She was free from a disability which she has had all her life.

DR. ROBERT T. MORRIS asked Doctor Martin to express his opinion as to the best procedure in a case seen by him two days previously in consultation, in which there had been an operation on the frontal sinus, the anterior wall being removed, making a bad depression, there still remains an opening into the ethmoid region. Danger of infection through the ethmoids was feared by Doctor Morris in case a flap were lifted and fat inserted to fill the depression. He stated that in this case the question of a blood clot filling also came up for discussion, but paraffine was finally decided upon.

SUPPURATIVE OSTEOMYELITIS WITH FAT IMPLANTATION

Doctor Morris said that he had experimented with fat grafts and believed that in nerve surgery it was an excellent method to lay a strip of fat along the line of suture, as by so doing it is possible to avoid the connective tissue invasion of the area of the suture, also with tendon splicing, a thin layer of fat interferes with the plastic exudate uniting tendons *en masse* again

Doctor Morris then spoke of a case of osteomyelitis seen by him during the past year. The patient, a young girl of twenty, had an osteomyelitis of the left femur, the entire femur from the head to the condyles being nearly twice the diameter of an ordinary femur, and this had been discharging for some years. The question of amputation was considered, but Doctor Morris having seen Doctor Downes' cases at Camp Upton determined to make a long trough the entire length of the diaphysis of the femur in V form, and then with the Carrel-Dakin solution there would be a safety in leaving open such an enormous wound. A culture was made of the staphylococcus aureus found in the wound and from this culture a vaccine was made and this was used in the hope of overcoming any further infection. This patient was seen by Doctor Morris about three months after operation, at which time she was perfectly well, the wound having healed and the patient having gained rapidly in flesh and color. While it was too early to make any final report upon this sort of case, the gain to date was at least out of our former experience.

DR H H M LYLE said that Doctor Martin has shown that dead spaces can be obliterated and healing hastened by employing fat grafts. Undoubtedly the use of this medium would be a valuable aid in the treatment of osteomyelitis, but the essential step in the whole treatment was the sterilization of the osteomyelitic cavity. Without this any method of plugging was doomed to failure.

The greatest thing learned in the war was that infected wounds could be sterilized, and it is upon this fact that the future treatment of osteomyelitis must advance. In the early years of the war the speaker had an extensive experience with osteomyelitis. This experience led to nothing but pessimism. In 1916 it was his privilege to be in charge of one of the first hospitals to adopt the Carrel-Dakin principles. The results obtained by these methods completely revolutionized his pessimism. The confidence coming from the knowledge that the vast majority of wounds could be sterilized by the proper application of the Carrel methods led to a prompt and energetic attack upon all cases of osteomyelitis. The results obtained were surprising. Doctor Gibson, of this Society, Doctor Sherman, of Pittsburgh, and others, saw many of the cases. In 1916 Doctor Lyle showed before the Surgical Section of the Academy Lumiere plates illustrating the course of healing of compound fractures with osteomyelitis. Formerly it used to take months and months to obtain a closure. With the advent of the Carrel methods it was obtained in

weeks In some of the cases shown in 1916 the time required was only twenty-eight days from the time of the original infection

It must also be remembered that it is not always necessary to obliterate the cavity if it is sterile and can be maintained so by closure Doctor Lyle has in his possession X-ray plates showing this phenomenon Examples of such closures are seen after bone cysts, sterilized Brodie's abscesses, and cavities left after curetting out giant-cell sarcomas, etc Surgeons have been taught that they cannot close empyemas until the cavity was obliterated This teaching is not strictly correct If one can sterilize an empyema it is possible in a very large percentage of cases to close the chest wall before the cavity is obliterated

DR EDWIN BEER called attention to Doctor Martin's remark that before introducing a fat graft in these cases "it was important to get complete hæmostasis in the cavity," this he had considered very difficult to obtain, and in doing a radical operation for osteomyelitis of the long bones it was almost impossible to obtain complete hæmostasis except by using very intense dry heat as suggested by Mosetig Moorhof When overhanging soft parts are sutured or nailed (Neuber) into the bone gutter there is danger of infection and further trouble with incomplete hæmostasis It is just possible that the fat in these grafts acts as a hæmostatic in cases described by Kolisher (pustatectomies), and this would explain some of Doctor Martin's successful results

DR SEWARD ERDMAN stated that he recently had three cases on his service in a military hospital in which a different method of plugging the cavity was resorted to, and in two of these cases with apparent success All these cases were of gunshot wounds, seton wounds with compound fracture, two in the humerus and one in the femur Doctor Erdman said that the obliteration of the cavity by the removal of the outer wall was not always practical in such cases, and instead of using free transplants of fat without blood supply a pedicled flap of muscle tissue was drawn through the tunnel in the bone He referred in this connection to the use of muscle as a hæmostatic in cranial surgery He said that the piece of muscle must be larger than what would apparently fill the hole because of the tendency to shrink, and also that this flap should be sufficiently divided at its pedicle so that it would not retract Also, that it usually was found necessary to suture the flap on its distal side to make sure of it maintaining the desired position He also called attention to the fact that if the osteomyelitis is in the vicinity of joints and there are channels leading into the joint it is impossible to obliterate these by drainage or by chiselling away the bony framework Two such cases under his care were treated by resection of the joint, and both healed very satisfactorily

DR JOHN DOUGLAS said that Doctor Martin's success suggested that the method of free fat transplant would be an easy one to follow, but that he did not consider it to be easy at all He referred to a case of his own on which he operated about three years ago in which there was a

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large cavity with much thickened extremity of the bone, and in which he tried a transplant without success, the patient was thirty-four years of age and had a chronic osteomyelitis of the femur of fifteen years' duration. The lower end of the bone was enormously thickened and the cortex so thickened that an X-ray picture showed no cavity. It had been operated on several times, resulting in a large amount of scar tissue. At the time Doctor Douglas operated there was practically an acute condition, a recent abscess formation. This he curetted and sterilized to the best of his ability, and, believing that a free transplant would not grow, he made a flap transplant, leaving the pedicle attached, thus blocking, as he thought, the cavity completely, this was, however, unsuccessful, the patient developing a small sinus and returning nine months ago, at which time he was kept under Carrel-Dakin treatment for over a month when negative smears were repeatedly obtained from the wound. The cavity was then opened as far as possible, and it was found impossible to make a gutter because the cavity went to the true condyles. After thoroughly sterilizing the cavity a free flap was removed from the abdominal wall with which the cavity was packed, nevertheless, there still persists an unclosed cavity in the bone. Doctor Douglas then referred to a boy of nine years, suffering from an osteomyelitis of the upper end of the tibia. After six or seven operations in another hospital there still persisted a cavity of considerable size, and when the case came under Doctor Douglas' care he scooped out the cavity and found a very thin anterior wall. He did not believe the cavity would close and he therefore tried to break down the walls, having no curved chisel he used a curved periosteal elevator inside the cavity as a chisel and thus broke down through the anterolateral wall of bone without cutting the periosteum. He then turned in these flaps and used the Carrel-Dakin treatment, and he was glad to say that when this patient was last seen the wound was entirely healed.

DR. FREDERIC KAMMLERER said he had attempted fat transplantation into bone cavities before the war on several occasions, but had had nothing but failures. One of his assistants at U. S. General Hospital No. 12, Major King, had, however, demonstrated to him, in a case of osteomyelitis of the tibia following a compound fracture (gunshot), the beautiful results obtained by fat transplantations after thorough disinfection of the bone cavity with Dakin's solution. Thorough disinfection was, of course, as Doctor Lyle had said, the principal factor in all these cases.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held October 6, 1919

The President, DR GEORGE C ROSS, in the chair

ADVANCED CARCINOMA OF BREAST, NO RECURRENCE SEVEN YEARS AFTER OPERATION

DR ASTLEY P C ASHHURST presented this patient as an encouragement toward doing thorough and wide-spread excisions for carcinoma. If in such a case as the present cure can be obtained by such means, how much more certainly should cure be anticipated if the same type of radical operation were uniformly adopted in early cases? He added that he had had occasion recently to operate on a case of wide-spread local recurrence in a case of carcinoma of the breast, one year after another surgeon had done a very incomplete operation, although the clinical diagnosis had been carcinoma from the first. This fact seemed to indicate that some surgeons were still so skeptical of cure ever being attained that they considered it not worth their while to expend the time and skill necessary for a complete extirpation. In the case of recurrence to which reference had just been made, the surgeon at the first operation not only did not excise the pectoral muscles, but he did not expose the axilla at all, nor did he even remove all the glandular tissue of the breast, yet the clinical diagnosis, confirmed by histological study, had been carcinoma from the first! He desired also to make a plea for habitual roentgenization of carcinoma patients after operation. In the case of the patient now presented, post-operative roentgen therapy was continued a long time.

The patient, a woman, forty-five years of age, was admitted to the Episcopal Hospital, August 3, 1912. There was a typical "rose ulcer" 7.5 by 5 cm in diameter in the upper outer quadrant of the right breast. This ulcer had commenced six months previously, and for two years before that time the woman had known she had a tumor in her breast. When examined there was a hard tumor, the size of a goose egg, beneath the ulcer. This tumor was freely movable in all directions. There was a palpable and visible mass of lymphatics in the axilla, which also was movable. The ulcer was covered with an adherent gray slough. No lymph-nodes were palpable above the clavicle. There was tenderness over the liver, but no evidence of metastasis to this organ. The left breast was normal.

Operation, under ether anæsthesia, was done August 5, 1912, including

ADVANCED CARCINOMA OF THE BREAST

a clean dissection of the entire axilla, and removal of its contents, both pectoral muscles, and a wide area of superficial and deep fascia (beyond mid-line at sternum, and down almost to umbilicus) in one mass. It was possible to close all the wound except for a space 5 by 2.5 cm below the clavicle. The time of the operation was three and one-half hours, and at its conclusion the patient received one litre of saline solution intravenously, being almost pulseless. (The excised specimen is illustrated in Plates V and VI of the speaker's text-book of surgery.)

By the second day after operation convalescence was established. Many of the sutures did not hold, some of the skin edges became necrotic, and six weeks after operation there was a clean granulating area the size of two palms. On September 30, this had contracted to an area the size of one palm, and this was covered with Thiersch grafts. Meanwhile roentgen ray treatment was pursued for a number of months.

The patient was kept under observation.

March, 1914. Her health was feeble, and she could not do much work. There was still an unhealed area, 2 cm in diameter, which scabbed over from time to time. There was no swelling of hand or forearm, and only slight oedema of the upper arm, but the oedema increased if the arm was used much. She could get her hand to her head and back to her buttocks, but both motions were weak, and the latter painful. The extensive cicatrix sometimes caused a sticking pain in her lung, but there was no evidence of pulmonary metastasis.

August, 1915. Condition about the same.

September 24, 1919. Since the last note the patient's general condition has markedly improved. She does her own housework and looks after an epileptic son. The entire right anterior thorax is covered by skin tightly adherent to the ribs, but there is no evidence of recurrence locally or of metastasis. She has good use of her arm, raising her hand easily above her head, and putting it without difficulty to the small of her back. Except for slight weakness she thinks it as useful as her left arm. There is scarcely appreciable swelling of the hand and none of the forearm or arm. During the past year her appendix was removed at the Philadelphia General Hospital.

DR D B PFEIFFER called attention to the picture circulated by Doctor Ashhurst in which the outline of the tumor is very sharply defined from the surrounding fat and breast parenchyma. If this is a fair representation of the growth it would indicate a rather different type of tumor pathologically from the kind that are ordinarily met with. It is well known that tumors which well merit the name of carcinoma still show the most remarkable variations in character, and particularly in the most important characteristics of infiltration and spread. He had seen many cases in which there was a comparatively huge primary mass and but little spread and *per contra* others that produced large and early metastasis from an insignificant appearing primary growth. He recalled one

case with axillary metastasis so extensive as to defy complete removal, which required the most minute search through the breast before the primary growth could be found. It seemed to him—without wishing to detract from Doctor Ashhurst's excellent result—that the underlying pathology is more influential in the result than the completeness of the operation, for has it not been the lot of all surgeons to operate in earlier and seemingly more favorable cases only to find that they have not been able to get beyond the carcinomatous permeation? Of course, he believed, as does every one, that radical operation for carcinoma of the breast should be as extensive as possible, and this case teaches that we should not lightly consider any case as inoperable. It will be more unfortunate, however, if any should consider that by punctilious completeness of operation the handicap of late surgery could be overcome.

DR J STEWART RODMAN recalled two cases in which his father operated. One was a sloughing tumor and the patient when last heard from was well eleven years after operation. The other was one of a growth of each breast. This patient was well eight years after the first operation and seven years after the second. Undoubtedly cures do occur even in these advanced cases if the operation is carefully and thoroughly done.

DR JOHN B ROBERTS recalled one case of malignant tumor of the breast which he removed about 1899, in which the woman died about three years ago, making the period of cure somewhere about seventeen years. The tumor was not a sloughing growth, but was quite as big as a woman's fist. He did a thorough operation, removing the glands in the axilla and he thought above the clavicle. He did not remember whether the tumor was examined microscopically, but clinically it had every appearance of being a large malignant growth. The patient was about sixty to sixty-five years old.

DR J LEON HERMAN said that a tabulated list of the reported instances of late recurrence of carcinoma after radical amputation of the breast is given by Doctors Deaver, McFarland and himself in their book on "Diseases of the Breast." A period of thirty years was the longest interval of time intervening between the time of operation and the reappearance of the cancer. There were, of course, all varieties of carcinoma included in this series.

The excellent result obtained by Doctor Ashhurst in this case illustrates the possibility of cure in mammary cancer by radical operation, even though the local appearance of the tumor indicates an advanced state of the disease.

It is of interest to recall that Doctor Halsted devised the radical operation and advised its routine employment with the knowledge that Volkmann and others had obtained far better results in advanced cases by removal of the pectoral muscles, together with the breast, than had been obtained in early cases by simple amputation of the diseased breast.

DOCTOR ASHHURST, closing, said that he had no doubt that the malig-

HYSTERECTOMY FOR CHORIO-EPITHELIOMA

nancy of different specimens of cancer varies a great deal. He thought also that diminished lymphatic activity is to be taken into consideration. In patients nearly eighty years old it seems useless to do an extensive operation. If we merely amputate the breast there is not likely to be subsequent trouble. But it ought to be remembered how far the mammary gland extends beyond that which one sees. If one thinks the glandular tissue occupies a very small area, he shall be deceived. It extends nearly up to the clavicle, out into the axilla, and down toward the epigastrium. The entire mammary gland should be removed even in these incomplete operations on *very aged* patients.

HYSTERECTOMY FOR CHORIO-EPITHELIOMA, NO RECURRENCE SIX YEARS AFTER OPERATION

DOCTOR ASHHURST said that the two following cases were presented especially to emphasize the value of certain *measures of routine*.

1 Pathological examination of uterine scrapings in cases of abortion or miscarriage

2 Removal of the cervix along with the uterus in abdominal hysterectomy. In 3 out of the last 17 hysterectomies he had done, for fibroids there had been coincident carcinoma of the cervix.

Chorio-epithelioma, or deciduoma malignum (Sanger, 1888), is an exceedingly malignant tumor growing in the body of the uterus after pregnancy. The pregnancy frequently is terminated before term, and the most favorable cases are those in which the diagnosis is made by the pathologist from examination of retained tissues removed in such cases. Such examination never should be neglected. The tumor probably arises from the chorionic and not from the decidual tissues, it behaves like the most malignant types of sarcoma, giving early venous metastasis, especially to the lungs (78 per cent) and vagina (54 per cent), according to Doiland.

Agnes H., forty-two years of age, was admitted to the Episcopal Hospital August 9, 1913, for a recent abortion after a few weeks' pregnancy. The uterus was curetted, and the scrapings sent to the laboratory for examination, as a matter of routine. The pathological report (Dr. C. Y. White) showing a chorio-epithelioma, abdominal panhysterectomy was done August 19, 1913. The appendix vermiformis, and left tube and ovary, the latter being cystic, were removed with the uterus, but the right tube and ovary were left. The uterus was slightly enlarged, and when opened, a papillomatous tumor was found at the fundus. (The specimen is illustrated in Fig. 1031 of the speaker's text-book of surgery.)

The patient has been kept under observation since operation, and is still in excellent health. Examination in August, 1919, six years after operation, disclosed no evidence of recurrence or metastasis. She was forty-eight years of age, and for the last year had complained of symptoms of the menopause.

PHILADELPHIA ACADEMY OF SURGERY

Panhysterectomy for Fibroids, Carcinoma of the Cervix Discovered in the Laboratory, No Recurrence Three Years After Operation

Cora L., thirty-six years of age, negress, was admitted to the Episcopal Hospital September 18, 1916, for profuse metrorrhagia. This was checked in the Receiving Ward by twisting on its pedicle a polyp which was protruding from the cervix. The patient's hæmoglobin was only 25 per cent. On September 22, because slight fever persisted, she was etherized, the soft and dilated cervix was caught in volsellum forceps, drawn down to the vulva, and the pedicle of the polyp, about 0.75 cm. in diameter and 6 cm. long, attached just above the cervix, was divided with scissors. The polyp itself was about 6 cm. in diameter. Very moderate bleeding occurred from the attachment of the polyp. The uterus was the seat of numerous fibroids.

October 6, 1916, two weeks after removal of the polyp, the patient's fever having subsided, and her hæmoglobin having risen to 35 per cent., the abdomen was opened, and complete panhysterectomy was done (*i.e.*, the uterus including the cervix and both tubes and ovaries were removed). The uterus was of medium size, containing several subperitoneal fibroids the size of hen's eggs or larger. Recovery was uneventful.

The laboratory report (Dr. C. Y. White) was that the cervix was the seat of *advanced epithelioma*.

The patient has been kept under observation and now, three years after operation, pelvic examination discloses no symptoms of recurrence, nor is there any evidence of metastasis.

GUNSHOT WOUNDS OF THE VASCULAR SYSTEM

DR. ASTLEY P. C. ASHHURST reported the following cases:

CASE I—Dyslesion of axillary artery from bullet wound, death ten hours after ligation.

Tony P., twenty-six years of age, was admitted to the Episcopal Hospital December 31, 1916, immediately after having been shot, while an innocent bystander in a street fight. The wound of entrance was at the posterior edge of the right deltoid, close to its humeral insertion, and there was no wound of exit. X-rays localized the bullet lodged against the second right rib. His radial pulse was equal on both sides, and apart from slight pain and swelling in the axilla, there were no serious symptoms. On the day after admission, however, weakness of the muscles supplied by the median nerve and paralysis of those supplied by the musculospiral nerve were noted. It was determined to explore the axilla to ascertain the nature of the nerve lesions.

Operation, January 5, 1917, by Doctor Ashhurst. Ether anaesthesia.

An incision was made from the middle of the clavicle downward and outward, in the space between the deltoid and pectoralis major, exposing the pectoralis minor. A finger was then passed

under the latter muscle, preparatory to its division, for exposure of the axillary plexus. As soon as the finger emerged at the lower border of the pectoralis minor a gush of arterial blood burst through at both borders of the muscle. It was evident that the bullet had injured the axillary artery and the primary bleeding had been checked by a clot, or that a slough in the wall of the artery had been separated only when the finger entered the axilla. The profuse hemorrhage was checked temporarily by the operator compressing the axillary artery with his left finger just below the clavicle, and with his right finger below the pectoralis minor. Removal of either finger released a perfect flood of arterial blood. Doctor Spruance, who was assisting in the operation, was then intrusted with digital control of the distal end of the artery, thus releasing the operator's right hand. Attempts were then made to clamp the artery above the lesion, but these proved ineffectual, owing to the depth of the wound, and the inability to distinguish the structures. Doctor Spruance then compressed the subclavian against the first rib, controlling hemorrhage from the proximal end of the axillary, while the operator compressed the distal end and tried to clamp it, this also proved ineffectual at first, it being impossible to clamp the artery without pinching one or other of the nerve trunks, but finally the clamp was properly placed and the distal end ceased to bleed. Doctor Spruance then compressed the axillary just below the clavicle, while Doctor Ashhurst ligated (with a double strand of No. 2 chromic catgut) the third portion of the subclavian by the usual incision above the clavicle. This at once stopped the pulse at the wrist. After suturing the cervical incision, the axillary wound was again exposed and found to be dry. The axillary incision was then enlarged, dividing the tendons of the pectoralis major and minor. Removal of the hæmostats still in the axillary wound then was begun, removal of the last hæmostat was again followed by profuse hemorrhage which was not controlled by digital compression of the axillary below the bleeding point. It was now found that this profuse hemorrhage came as recurrent bleeding from the subscapular artery, there being a bullet hole in the axillary just opposite the origin of this artery (Fig. 1). Therefore the axillary artery was tied above and below the hole, and the subscapular artery was tied also. The axillary plexus of nerves was then examined; the median nerve had been bruised by hæmostats, the musculospiral nerve was contused, presumably by the bullet, the ulnar and musculocutaneous nerves were undamaged. The divided muscles were repaired and the wound closed. The patient was in a precarious condition as the result of hemorrhage, and died ten hours after operation, in spite of stimulation. It is possible that blood transfusion might have saved his life, but no donor was available.

CASE II—Recent bullet wound of right axillary artery, with diffuse traumatic aneurism, ligation of first portion of subclavian artery and of axillary artery above and below the wound. Recovery.

Charles W., a private of the 104th Infantry, U. S. A., was hit by a

machine-gun bullet in the Argonne Forest November 9, 1918, at 4 A M He was brought to Evacuation Hospital No 6 at Souilly, and operated on twenty hours later Fluoroscopic examination by Captain Angell showed the bullet superficially placed in the right pectoral region The wound of entrance was over the right shoulder posteriorly There was an immense pulsating hæmatoma occupying the entire right pectoral region, which was discolored by the extravasated blood The bullet was palpable just beneath the skin, and the hæmatoma appeared on the point of rupture There was no pulse at the right wrist

Under ether anæsthesia, immediate operation was undertaken, with the skillful assistance of Captain Morse and Lieut H S Kerchner It was determined to do preliminary ligation of the first portion of the subclavian, as the immense size of the hæmatoma rendered the third portion inaccessible through healthy tissues, and then to expose the axillary artery where wounded Accordingly an incision was made along the inner end of the right clavicle and downward for 7 cm over the sternum, and the inner end of the clavicle (2.5 cm) was resected The pleura was accidentally punctured The first portion of the subclavian artery was then exposed, and the pneumogastric nerve and its recurrent laryngeal branch were identified Owing to the large size of the hæmatoma, these structures lay at an abnormal depth A ligature of No 2 chromic catgut was passed around the artery distal to the nerve (Fig 2) On tying this ligature pulsation in the hæmatoma stopped at once, and the mass decreased in size The operative incision was closed in layers, without drainage A second incision was now made in the line of the axillary artery from the clavicle to the anterior axillary fold, dividing the pectoralis major and minor muscles The bullet was removed from beneath the skin, and the clots evacuated Free arterial bleeding then occurred from the proximal end of the axillary artery just distal to the clavicle, evidently recurrent through the thyroid axis and other branches of the subclavian distal to the ligature This bleeding was checked by the finger and then by hæmostatic forceps, when it was seen that the bullet had clearly and completely divided the first portion of the axillary artery, without injuring the vein (Fig 3) Both ends of the artery were ligated with No 2 chromic gut and the wound was left wide open, and drained by rubber tissue It was directed that the patient be not evacuated

The next day the patient's hand was warm, and the circulation appeared to be reëstablished He could flex his fingers, and the axillary plexus of nerves apparently had escaped injury He has been very hoarse since the operation, perhaps from operative injury of the recurrent laryngeal nerve The wounds were dressed the sternal wound was healthy, but the pectoral wound smelled of gas gangrene, and a smear showed the presence of the *B. aerogenes capsulatus* It is to be remembered that the tissues in the axilla were widely lacerated by the escaping blood and had been under increasing pressure from the hæmatoma for twenty hours before opera-

tion, and after operation were still deprived of their normal blood supply. At the time of operation the patient's condition did not warrant an excision of all the muscles which were infiltrated with blood. French anti-gas gangrene serum was administered, and the wound was treated with Dakin's solution according to Carrel's technic.

On the third day the patient was still very hoarse, but the pectoral wound looked better, though the muscles were still very spongy. It was noted that he was unable to extend his fingers or wrist, but it was not determined whether this was due to weakness or to a nerve lesion.

Five days after operation the patient appeared convalescent, though he was still very hoarse, and had a little cough, the wound was doing very well.

Six days after operation he was evacuated in good condition the sternal wound had remained clean, and the pectoral wound was doing well.

Inquiries from the War Department as to the patient's subsequent history have been unanswered.

CASE III—*Direct arterio-venous fistula of the axillary vessels following wound by shell fragment. Excision of vein, suture of artery. Recovery.*

George W., private, 39th Infantry, U S A., sustained a penetrating wound by a shell fragment August 1, 1918, in France. The wound of entrance was in the left deltoid region. He was taken to a hospital and put to bed. No operation was done. He did well, presenting no noteworthy symptoms. After a few days he got out of bed, and soon began to work about the ward. One night (about 2 A M.), eight or ten days after injury, he was awakened by pain in the left subclavicular region and down the left chest. Examination by the ward surgeon revealed a blowing murmur in the left subclavicular region. Previous examinations, he said, had shown a heart murmur, but nothing abnormal in the axillary region.

This patient first came under Doctor Ashhurst's notice seven months after his injury, in the Walter Reed General Hospital, Washington, D C., where he was in the service of Major E M Jones, who asked Doctor Ashhurst to operate. The disability consisted in inability to raise the arm above the head, this motion being only two-thirds of normal. There was a buzzing and whirring on palpation below the left clavicle, but the radial pulse on the two limbs was equal and synchronous, and the blood-pressure was normal on both sides. Skiagraphic examination showed a shell fragment 3 cm. anterior to the vertebral end of the fourth left rib. This fragment, of medium size, was producing no symptoms and its removal was not indicated.

On March 27, 1919, with the skillful assistance of Major Jones and Lieut J C Lawlor, Colonel Ashhurst operated under ether anæsthesia, as the site of the lesion evidently was high in the axilla, it was determined first to control the circulation by clamping the third portion of the subclavian artery, which was done through the

classical incision Next an incision was made, convex toward the greater tuberosity of the humerus, from the middle of the clavicle to the anterior axillary fold near the chest wall After ligating the cephalic vein, the tendon of the pectoralis major was divided, and the axillary artery was clamped just proximal to the origin of the subscapular artery The tendon of the pectoralis minor was then cut, and the clavicular origin of the pectoralis major divided for about 3 cm The lesion could then be identified, after dissection of scar tissue, as a direct arterio-venous fistula of the axillary vessels, involving the first portion of the axillary artery The outside diameter of the fistula was about 1 cm (Fig 4) Artery clamps were now applied just proximal and just distal to the lesion, and the clamps which for about one hour had been on the subclavian and on the third portion of the axillary were removed The axillary vein was carefully cleared, ligated above and below the lesion, cut across between the respective ligatures and the lesion, and dissected free as a pouch attached to the artery (Fig 4) A grooved director passed across the venous pouch through the fistula into the lumen of the artery, demonstrated completely the nature of the lesion Three interrupted sutures of fine linen were now passed through the arterial wall at the site of the fistulous opening, and were tied after cutting away the venous pouch from the artery Then a continuous through-and-through linen suture was applied to the artery, and the arterial clamps were removed There was absolutely no leakage from the suture line as the artery filled out and pulsated, but a branch of the acromio-thoracic artery below the lesion spurted actively and was tied The pectoralis major (not the minor) and the skin were closed separately with chromic gut, a small tube being left at the lower angle of the large wound The neck wound was closed without drainage The duration of the operation was three hours

Recovery was uneventful, no abnormal symptoms of any kind being observed, and function of the arm being gradually restored The patient returned to his home and has recently been carefully examined by Dr Lucian H Landry of New Orleans, one of Doctor Matas's associates, who courteously wrote to me September 15, 1919, that after a careful examination he considered the result a complete cure

CASE IV—*Circumscribed traumatic aneurism of sural artery following wound by shell fragment, obliterative endo-aneurismorrhaphy, recovery*

Richard B, first lieutenant, twenty-four years of age, U S A, suffered a perforating wound of the right popliteal space by a minute shell fragment September 26, 1918 The punctured wounds of entry and exit healed without any operative treatment, but after some weeks, while walking, he felt a sudden sharp pain in the bend of the knee and a pulsating tumor appeared He came under Doctor Ashhurst's notice, more than five months later, in March, 1919, at the Walter Reed General Hospital Low in the right popliteal

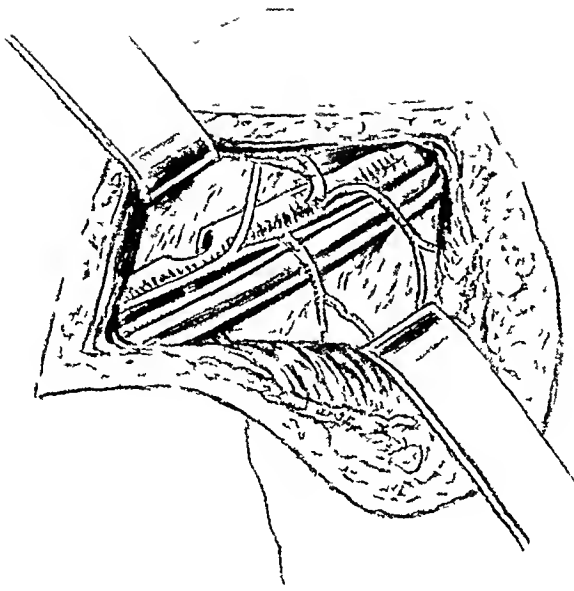


FIG 1

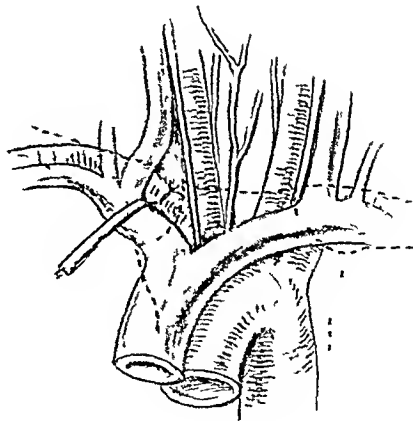


FIG 2

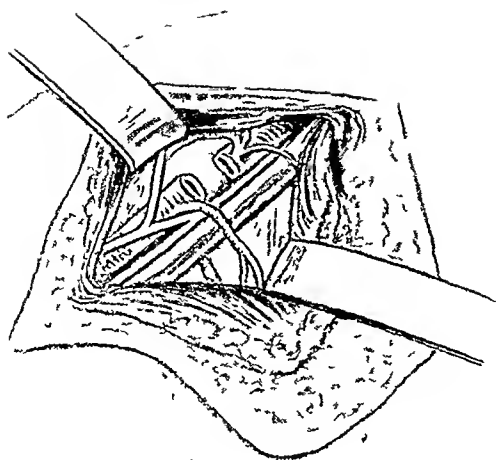


FIG 3

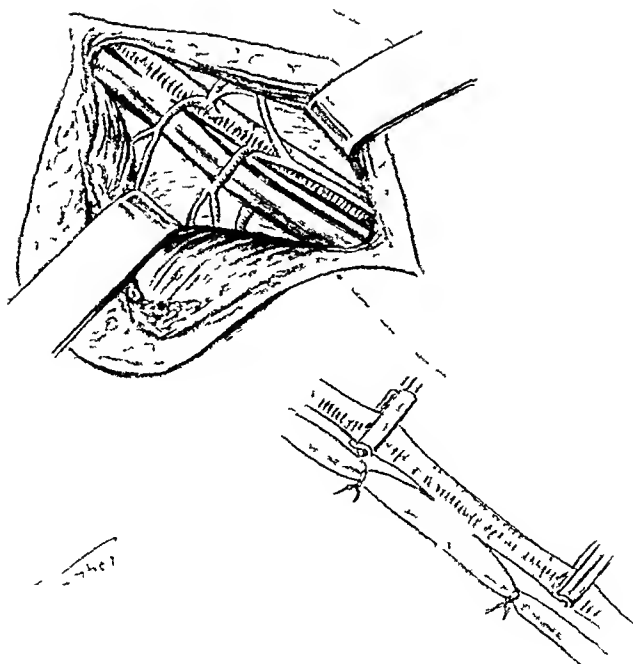


FIG 4

PERFORATING GUNSHOT WOUND OF THE ABDOMEN

space was a tense, hard, not tender swelling, 7 by 5 cm, its long axis corresponding to that of the limb. This swelling exhibited distinct expansile pulsation and bruit. There was no appreciable difference in the pulse below the knee in either leg.

Operation was undertaken March 6, 1919. Under Esmarch anaesthesia a longitudinal incision, 16 cm in length, was made over the popliteal space, and the deep fascia and heads of the gastrocnemius muscle, as well as the internal popliteal (posterior tibial) nerve, were dissected off the sac, all of these structures being densely adherent. The sac was opened on its median side, and some well organized clots were evacuated. The sac was found to be of the size of a large hen's egg; its walls were formed of organized granulation tissue, except for an area about 3 by 2 cm on the median and anterior surfaces, which was white and glistening, representing the original intima of the wounded artery, now spread out to form part of the sac wall. This patch of typical intima contained two minute orifices—one proximal, the other distal—about 2.75 cm apart, evidently representing the afferent and efferent channels for the blood. The proximal opening bled a little. There were no other openings in the sac. Most of the posterior wall of the sac was dissected free and excised, the arterial orifices were closed by linen sutures, and the remainder of the sac, which was too adherent to be excised easily, was obliterated by No. 000 chromic gut sutures. The fascia and skin were closed separately. The time of the operation was about one hour.

Recovery was uneventful, all the symptoms being relieved.

PERFORATING GUNSHOT WOUND OF THE ABDOMEN WITH INVOLVEMENT OF LIVER, KIDNEY AND SECONDARY INFECTION OF PLEURA

DR JOHN H. JOYSON reported the following case. B. R., private, Company L, 61st Infantry, was admitted to Evacuation Hospital No. 1, A. E. F., on September 6, 1918, at 3.30 P. M., with the diagnosis of gunshot wound, perforating, of the right abdomen. He had been wounded at 5 A. M. of the same day. On admission he was suffering from the effects of hemorrhage and was in poor condition. He presented on examination a large wound, probably of entrance, below the lower border of the thorax, about the nipple line on the right side, and a wound somewhat larger at a corresponding point posteriorly. Preparations were made for immediate operation. To render this possible blood transfusion was necessary, and was started at the commencement of the operation. The anterior wound first received attention, and was débrided, and the abdomen opened by a free incision. There was an extensive laceration of the right lobe of the liver, which was bleeding freely, and was the source of most of the abdominal hemorrhage. This was packed. The tract of the éclat was followed backward through the posterior peritoneum and the retroperitoneal space was opened widely. The right kidney was pal-

pated, and found to be badly lacerated. It was delivered through the opening into the peritoneal cavity, the pedicle ligated, and thus removed transperitoneally. The patient was then turned on his face, after partially closing the abdominal wound and packing the remainder down to and through the posterior peritoneum. The wound in the back, from which much of the blood which we had been pouring into the vein was meanwhile pouring out, was then widely debrided, exposing in the process a comminuted fracture of the eleventh rib, fragments of which were removed, and a large wound thus established traversing the entire upper abdomen. The posterior wound was also packed, the two packs, anterior and posterior, meeting, and the operation concluded. Contrary to expectations, the following day found the patient in very fair condition, and with undiminished pluck and cheerfulness. There were no evidences of peritoneal infection, and he was suffering from the effects of hemorrhage only. In spite of this, however, his after-course was most stormy, and not lacking in complications. It was not deemed wise to remove the packs after twenty-four hours, and begin Carreling as was our custom in ordinary gunshot wounds not permitting of primary suture. We have not been in the habit of using this method of treatment in wounds with a wide communication with the abdominal cavity, and it was decided to leave the packs in place for a longer time. Some of the gauze was removed on the third and the remainder on the fifth day, the latter date gas being administered. The anterior wound was found infected, and all sutures were removed. The general condition was good, there was a superficial infection of the posterior wound, as well as the anterior, streptococcal in nature, and two days later the wounds were Carrelled. Under this treatment they cleaned up rapidly, and the wound was steadily reduced in size by granulation. The temperature, however, gradually rose after a few days, and on the 5th of October he had a chill and a fever of 102° . He was still decidedly anæmic, and an annoying symptom appeared in the form of vomiting at intervals of once or twice a day, of a considerable amount of bile-stained fluid. At the time there appeared evidences of effusion in the lower part of the right chest, which aroused suspicion of an ascending subphrenic infection, for which there was ample explanation. The first aspiration of the pleural cavity was negative, but the second, on October 9, was positive, and 600 c c of light brown but sterile fluid were withdrawn. On the same day an exploration of the subphrenic space was made. A vertical incision across the twelfth rib exposed the same, and it was resected for three inches. The edge of the diaphragm was divided, underlying adhesions separated, and the subphrenic space exposed without opening the pleura. The wound of the liver, still gaping and covered with lymph and granulations, was uncovered, and the right upper abdomen, above and below the liver and over as far as the stomach, was examined, but with negative results. After this operation he was somewhat depressed, and my assistants, who

PERFORATING GUNSHOT WOUND OF THE ABDOMEN

were all deeply interested in the soldier, and pessimistic and hopeful by turns, were correspondingly lugubrious. Canceled again after two days. By the fifteenth the pleural fluid had reaccumulated and its presence was confirmed by examination of Lt Col George W Norris. Aspiration at this time yielded a fluid, which while still amber colored, showed the presence of streptococci, and on the following day the patient was again sent to the operating pavilion, and the chest drained by resection of the eighth rib in the mid-axillary line, and the insertion of drainage tubes. Following this procedure there was a slow but steady improvement marked by subsidence of temperature, cessation after a time of the vomiting, which we had been inclined at one time to view as a possible result of duodenal obstruction by some collection, and a slow improvement in the general condition. About this time, however, the patient developed a most harassing and troublesome cough which resisted all medication, but which, like the vomiting, finally subsided. A small fecal fistula had appeared, possibly as a result of the second operation, but by the first week in November this, too, had closed. Slight elevation of the temperature persisted from time to time until December. Finally, on January 13, as the thoracic sinus still persisted, and improvement seemed slow in the local findings, as far as the chest was concerned, although the abdominal wounds were by this time long cicatrized, the seventh rib was resected under gas-ether anæsthesia, and eight days later he was evacuated.

After leaving the evacuation hospital, he passed through two base hospitals, was sent back to the United States in March, and after another transfer was sent to the Walter Reed Hospital, from which he was discharged on October 4, 1919. The drainage tube was removed and replaced several times during this period of his hospitalization, but when examined on October 6 the wound was solidly healed, and had been so since May.

At present there is slight discomfort in the right side on deep breathing. Hæmoptysis, slight in amount, has been noted after unusual exertion. There is some limitation of expansion on the right side, no râles, a slight lateral curvature, a much depressed scar over the site of resection of the seventh rib, the other scars, anterior and posterior, solid and showing no signs of hernia. The man weighs nine pounds more than on entering the service, and looks to be in splendid health.

That this man survived was mainly due to the fact that in him we were dealing with a type of patient that unfortunately, while the rule in the army, is not the consistent type in civil life, as one quickly finds when one resumes wonted work. The healthy young male human animal, with unimpaired organs, and a marvellous reacting power, is possibly the nearest approach to the laboratory animal in responding to all of the measures for the treatment, operative or otherwise, for traumatic conditions and their concomitant complications of shock, hemorrhage and infection. We are enabled to follow the problem to its solution in a far

larger percentage of cases than we can in an equal number of adults representing a cross-section of the community in general. In their ability to react completely and rapidly from an apparently hopeless state due to pure shock or shock and hemorrhage combined, they resemble a healthy child, while able, of course, to take an amount of physical punishment far in excess of the latter. With them it is much less frequently a case of the operation being a success but the patient dying, their undamaged viscera and whatever portion of the nervous mechanism or undiscovered physiologic reservoir which is called into action in the production and the reaction from shock *per se*, standing them in good stead at every step in the pathway from the time the injury is inflicted until convalescence is complete.

STAB WOUND OF DIAPHRAGM AND STOMACH

DR JAMES H. BALDWIN reported this case to emphasize a fact well known to all surgeons, but not so well known to those who do not do surgery—that the earlier an abdominal perforation is treated, the more likelihood that the patient will recover and that most patients operated on in the first few hours after a perforation do recover.

E. B., aged twenty years, was admitted to the Methodist Hospital at midnight, August 26, 1919, with a history of having received a self-inflicted stab wound of the left chest at the eighth costal cartilage region, about one-half hour previously. The patient, on admission, was intoxicated, vomited freely, with a report of "no blood in the vomitus." The temperature was 98°, pulse, 80, respiration, 20. The wound, from which very little blood came and which did not look dangerous, was dressed by the interne, Doctor Harding, and orders given to watch the patient, making frequent chart records. In a short time the pulse rate began to increase, upper abdominal rigidity with marked pain and tenderness developed. I was sent for and operated at once, four or five hours after the receipt of the wound. A left rectus incision was made from the costal margin downward. On opening the peritoneal cavity, there was a gush of air and blood and the whole abdominal cavity seemed filled with bright red blood. This obscured the field, but with the use of large wet packs, the field could be cleared sufficiently to see a wound about one inch long in the greater curvature of the stomach, a few inches from the cardiac end. This was easily closed and the hemorrhage controlled. No other wound was found in the stomach or intestines. There was an opening through the diaphragm about one inch in length. By retracting the abdominal wall, this could be sutured and was closed with catgut. The abdominal wall incision was then closed as usual with two cigarette drains at the upper angle. The chest wound was then examined and it was found that the knife had severed the cartilage of the eighth rib.

The post-operative recovery was uneventful. Hot water was given in small amounts about twelve hours after the operation. The tempera-

STAB WOUND OF DIAPHRAGM AND STOMACH

ture and pulse were slightly elevated for a day or two, but soon dropped to normal, and the patient was discharged on the sixteenth day fully recovered.

DR JOHN H. JOPSON said that transthoracic penetration of the abdomen is a frequent injury in war surgery. Most of the cases are due to high explosives. He recalled four cases on which he operated, in which the missile or weapon went through the pleura and diaphragm, and in which he operated through the same route. In three of the cases the wounds were produced by shell fragments, in the fourth the injury was a bayonet wound, and in this case there were some points of similarity with the one reported by Doctor Baldwin. The soldier was going up to the trenches at night with a small group of men in a new area. They were mistaken in the darkness for Germans by another party of Americans, and in the mêlée this soldier received two penetrating bayonet wounds in the right chest, one in the second interspace, nipple line, and the other in the eleventh interspace, behind the post-axillary line. He was brought into the hospital in a few hours later in good condition. The upper wound in the front of the chest was first sutured. The lower and posterior wound was then explored. The chest was widely opened in the eleventh interspace, débriding the wound in this procedure, and a wound of the diaphragm discovered one and a half inches from its costal attachment. This was easily reached and sutured. The lung was collapsed, but not bleeding. Air-tight closure of wound was made. The patient was then turned on his back, and the abdomen opened through the right rectus muscle. Little blood was found in the abdomen, there was no injury of the hollow viscera, but another wound of the diaphragm was discovered near the mid-line and behind the dome of the liver, and so far back as to be inaccessible to suture through the abdominal wound. We therefore closed this wound, and reopened the wound in the thorax, resecting the eleventh rib to give a better exposure. The bayonet had gone through the diaphragm, probably wounding the liver slightly on the retroperitoneal surface, and re-entered the pleural cavity near the mid-line, passing along the arc of the diaphragmatic curve. By pushing down the diaphragm and liver, after excision of the rib, we were enabled, with some difficulty, to suture the oval opening in the diaphragm and without the aid of negative pressure. The patient breathed well in the prone position, except when the downward pressure was made as described. Air-tight closure of the pleura for a second time. The man developed a streptococcic infection of the pleura, which demanded reopening of the chest on the sixth day, and the insertion of Carrel tubes. Chest irrigation was not well borne, and simple drainage was substituted for it. The patient reacted well to this plan of treatment, and was evacuated in good condition five weeks after admission, with a sinus remaining. Such experiences were rare, and we seldom saw bayonet wounds of any kind, and these usually accidental. The advantages of the transthoracic route for certain lesions in the subphrenic space is well recognized.

Two cases of shrapnel wounds of the liver with lodgment of the foreign body in that organ were treated in this way. In another case the wound in the liver was exposed transpleurally and packed, no foreign body was found, although the abdomen was opened again from in front, and explored. All of these cases recovered.

DR MORRIS BOOTH MILLER said that in the spring of 1917 he had a case similar to Doctor Baldwin's, except that the stab wound was farther to the left and hence an interspace higher up. There was a transpleural wound of the abdomen. He opened the pleura and sutured the diaphragm from above. The wound was made by a stiletto in the hand of an Italian who had evidently meant to make a thorough job by turning his hand as he struck. This gave a substantial slash of the diaphragm. After suturing the diaphragm he opened the abdomen but found no visceral perforation, one or two little cuts had been made in the omentum. He was not so fortunate as Doctor Baldwin, because his man developed a virulent infection of the colon bacillus type and in spite of the fact that early drainage of the pleura was instituted the patient succumbed to the infection.

CORRESPONDENCE

THE PREPARATION OF THE SKIN FOR OPERATION WITH SOLUTION OF RUBBER AND ETHER INSTEAD OF TINCTURE OF IODINE

EDITOR, ANNALS OF SURGERY

While all the merit for the simplification of the technic of preparing the skin previous to surgical operation is due to the venerable surgeon of Fiume, Doctor Grossich, now engaged in political strife for a patriotic ideal, the use of rubber and ether solution represents a progress over the Grossich method of using tincture of iodine. We have employed the plain rubber cement used in repairing tires and sold at any store selling motor and bicycle supplies, and the solution is prepared in the following manner:

A glass container, with ground glass cover, is sterilized and filled with one part of the rubber cement and about five parts of ether. The container is shaken, so as to dissolve the rubber cement in the ether, and is allowed to stand for a few days. The solution is applied to the dried skin by painting it over the operative field, as is done with tincture of iodine. The solution dries almost immediately, so a second and, if desired, a third coat can be applied. The surgeon can then proceed to operate. The ether rubber solution leaves on the skin a film of rubber that will adhere to the skin and prevent any infection from the skin itself.

The drawbacks of tincture of iodine are so well known that we shall not even mention them, we shall only mention some of the advantages, especially in cases of laparotomy, of the ether rubber solution. It does not irritate even the most delicate skin. The tincture of iodine applied to the skin has been the cause of many post-operative adhesions, because, notwithstanding the fact that the skin was covered with sterile gauze, the direct contact with the iodine, or even its vapors, helped by the friction of the abdominal organs against the gauze, caused irritation of the peritoneal surfaces, resulting in the formation of adhesions. This drawback is completely eliminated if rubber ether solution is used. The use of the ether rubber solution has also allowed us to reduce the amount of packing around the laparotomy incision, in fact, when performing aseptic or quasi-aseptic operations, such as gastro-enterostomies or appendectomies in non-acute cases, we do not cover the abdomen as is usually done, but use sheets with large rectangular holes and we lay the organs that are extracted from the abdomen right on the abdomen itself without any interposition of gauze, because the friction of the gauze, whether dry or wet, is a great help to the formation of adhesions, while

the rubber film deposited on the skin is practically non-irritating to the peritoneal organs, and we limit, when necessary, the packing to the indispensable to prevent leakage of infected contents in the abdominal cavity

If adhesive plaster is used to hold the dressing, the plaster adheres better to the skin prepared with the ether rubber cement than to the bare skin, as described in a short note in the *Journal of the A M A*¹ The ether rubber solution is absolutely sterile as shown by the report appended,² and we advise allowing the solution to stand for a few days, so as to be sure that the solution becomes sterile through the action of the ether

We are now trying to color the solution so that its application to the operative field can be made more easily uniform and even, when we have found which appears to be the most suitable color, we shall make another short report of the results obtained

ANGELO L. SORESI, M D ,
New York, N Y

SPLENECTOMY UNDER LOCAL ANÆSTHESIA

EDITOR ANNALS OF SURGERY

I desire to place on record the following case

The patient was a woman, aged fifty years in 1912, when her spleen was removed under local anæsthesia Resident of St Louis County, Mo, housewife, mother of ten children, of whom six were alive and well Sixteen years previous had had chills and fever of two months' duration She has had severe attacks of pain and cramping in the abdomen, sometimes in one quadrant and sometimes in another The menses were regular until 1911 in January Since then they were irregular, at intervals of five or six months, with flooding, nervousness, hot flushes, etc, were absent She came seeking relief from bladder trouble and pain in the back For six years she had noticed an irregular tumefaction in the lower abdomen She relates that at first it was movable Three months before the original examination it became suddenly larger, and since then was immovable, and the pain in the bladder and the lower part of the back increased She also had pain in the higher part of

¹ A L. Soresi "How to make even poor adhesive plaster adhere" *Journal A M A*, September 6, 1919

² The rubber cement in ether given me to examine bacteriologically was cultured in the following media Plain broth, glucose broth, plain agar, glucose agar, and blood agar Gelatin plates were also made All media were adjusted to hydrogen-ion concentration of $pH = 7.1$

All sets of media were cultured both aerobically and anaerobically

There was no growth obtained on any media after twelve days, when the cultures were discarded as sterile

October 14, 1919

W MOITRIER.

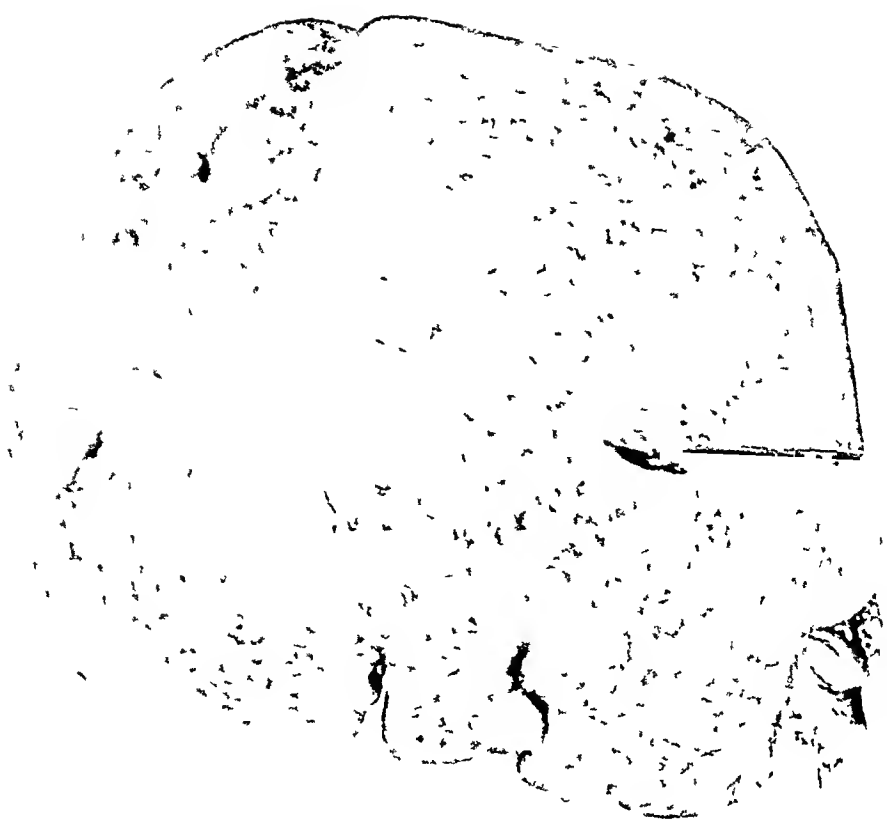


FIG 1—Convex surface of spleen

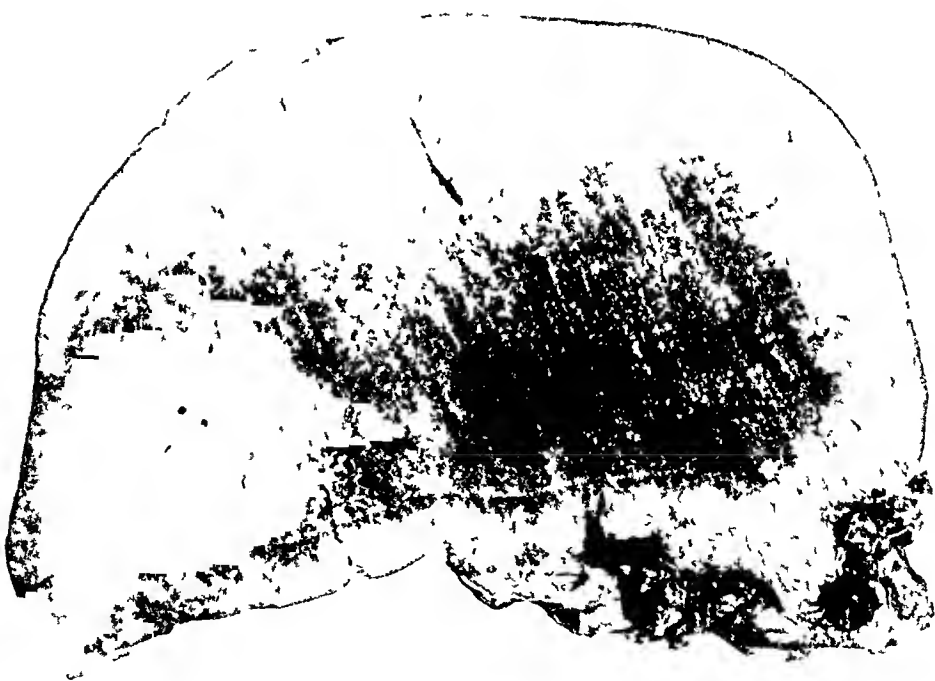


FIG 2—Cut surface of spleen Note structure

the back. The patient complained of much gas in the bowels, especially at night, and constipation was an increasingly troublesome factor.

Examination—All four quadrants of the abdomen were tender. The tumor filled the pelvis and presented above the pubis. It was irregular in its outlines and very hard, and should have suggested spleen on examination except that the characteristic notches were presented upward, giving a very different impression than that produced when they present normally. On bimanual examination the mass was found wedged in the pelvis and apparently continuous with the uterus, or at least not separable. The mass was tender and immobile and of a hard consistency.

Operation, under ether, disclosed that the tumor was an enlarged spleen wedged in the pelvis. It was freed and returned to its normal position after the surface had been rubbed with gauze. It was hoped that antimalarial treatment and the relief of passive congestion which the torsion of the pedicle had caused might result in the resolution of the tumor. A further inspection of the abdomen showed a definitely inflamed appendix and a gall-bladder full of stones. The appendix and the stones were removed and the gall-bladder drained. The patient took the ether poorly and the recovery period was stormy and characterized by cyanosis and irregular cardiac action. The period of nausea was prolonged. The spleen was retained by abdominal binders and pads and the head of the bed was kept low. The wounds progressed favorably. During her recovery period a very careful examination of the blood gave no information to guide us. Nevertheless, an intensive antimalarial course was given without result. She returned by agreement four months later. The spleen had slipped down again, but was still mobile, the bladder symptoms were as bad as ever, although practice of the knee-chest position tended to relieve.

Second Operation—Novocaine and adrenalin solution were used in the skin and the line of incision. Quinine and urea hydrochloride solution was injected deeply at same distance on each side. A high rectus incision was made and the spleen pedicle lifted into view. A multiple ligation was done with careful avoidance of the tail of the spleen, Pagenstecher linen being used. Then the pedicle was divided and the spleen afterward lifted from the abdomen. The length of the pedicle greatly facilitated the procedure. The recovery period was remarkably smooth in contrast to that after the first operation. The wound healed well, the cardinal symptoms were relieved. Several blood studies did not reveal any marked disturbance. The patient remains well.

Pathology—The spleen weighed three and one-half pounds. It was fairly smooth on its surface except for some whitish deposits thickening the capsule. The cut surface showed an appearance of structure, illustrated by the photograph, as of a cortex and medulla. The sections were prepared by the kindness of Doctor Hertzler and showed great increase of cells of an endothelial type, *i e*, large

cells with a clear glassy cytoplasm and small, well stained nuclei This seems to conform to the Gaucher type, although the history is not classical

Comment—In cases of floating spleen the long pedicle renders splenectomy under local anæsthesia feasible

ELMER D TWYMAN, M D ,
Kansas City, Mo

DISLOCATION OF THE FIVE METATARSAL BONES DOWNWARD AND OUTWARD FROM THE TARSUS WITHOUT FRACTURE

EDITOR, ANNALS OF SURGERY

The excuse for reporting this case lies mainly in its rarity In looking up the literature we find that there are only ten cases reported (Stimson, on Fractures and Dislocations) Furthermore, neither of us in quite an extensive emergency practice, has ever seen its duplicate

The subject of this report, Mr R, married, aged fifty-five, was injured while working in a soap factory Claims to have never been injured before The present accident occurred when a 1200-pound soap vat fell on him, causing a fracture of both the tibia and fibula above the ankle-joint in the right leg, and a dislocation of the metatarsal bones in the left foot The causative factor in this case undoubtedly must have been direct violence, first dislocating the metatarsal bones posteriorly and then outwardly If one will look at the anatomy of the second metatarsal bone he will see that there is an interlocking between the second metatarsal and the first and third cuneiform bones so that a dislocation of this type without fracture must involve either an anterior or a posterior dislocation of the second metatarsal bone

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FRANCIS J CARR, M D ,
FRANCIS WILLIAM MCGUIRE, M D ,
Buffalo, N Y

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FIG 1 —Dislocation downward and outward from the tarsus of the entire metatarsus

—

12

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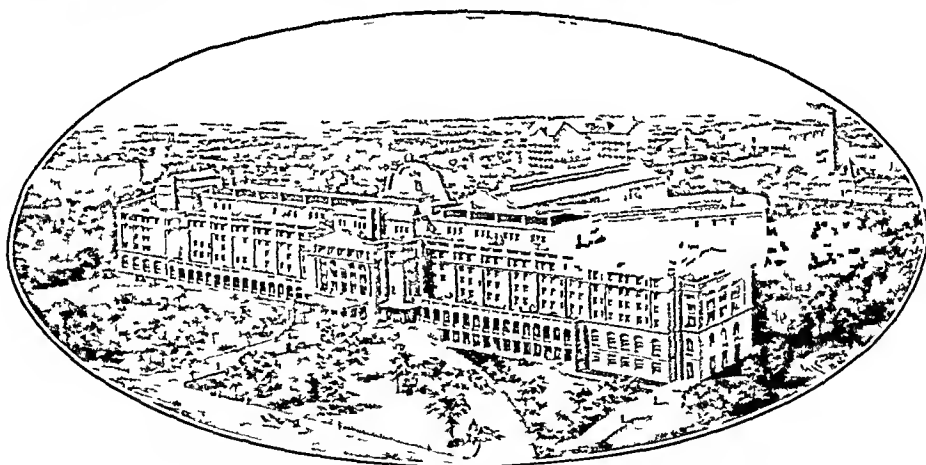
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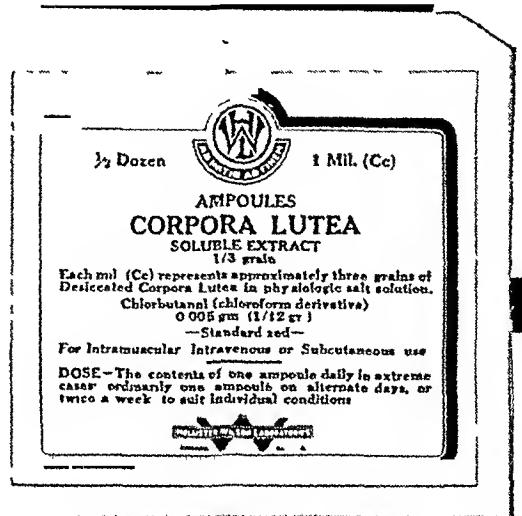
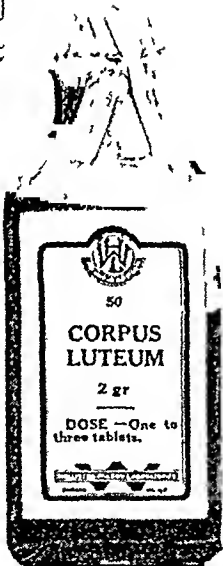
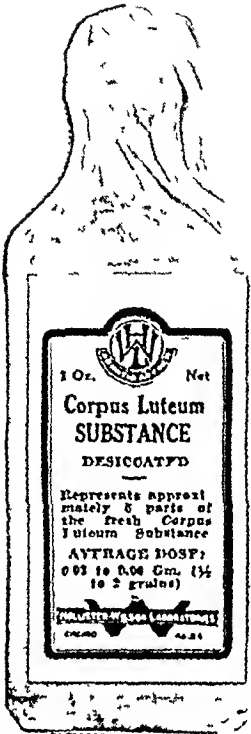
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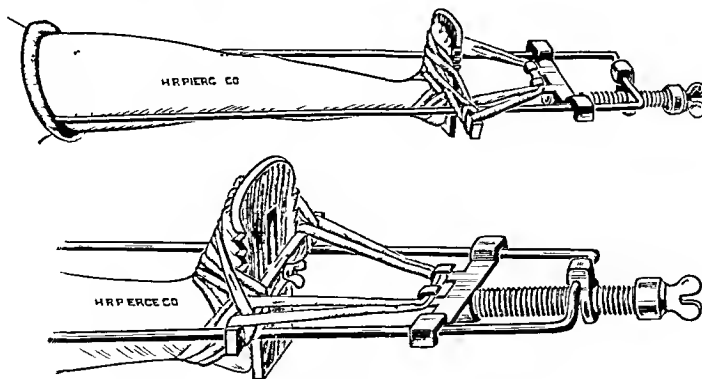
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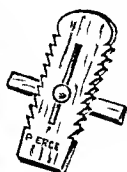




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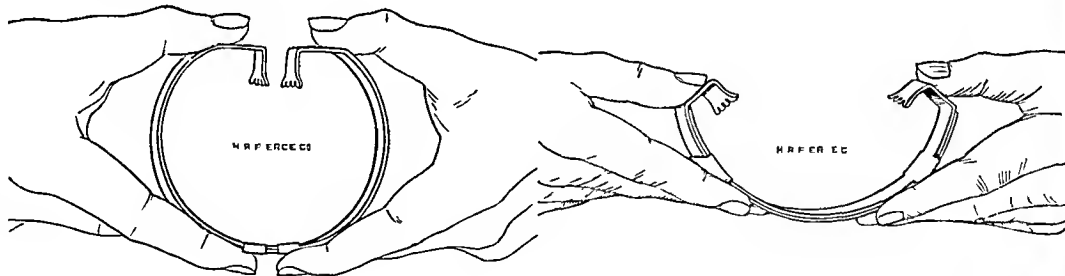
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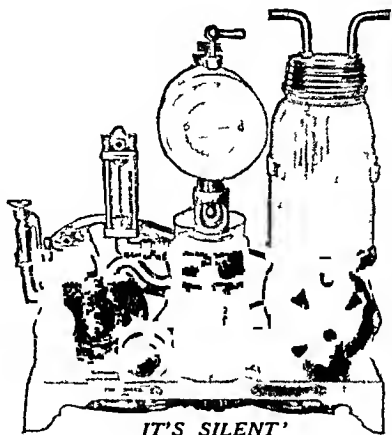
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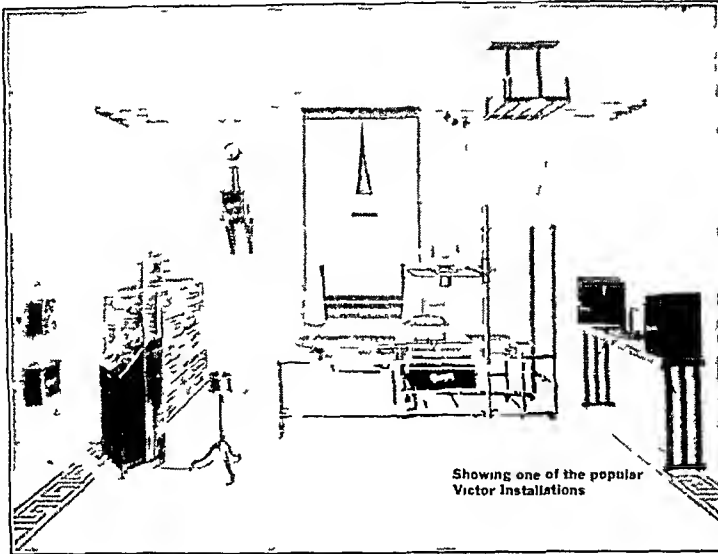


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A Monthly Review of Surgical Science and Practice

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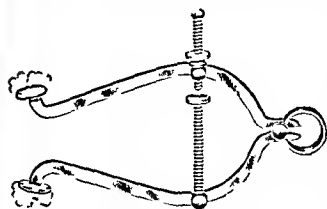
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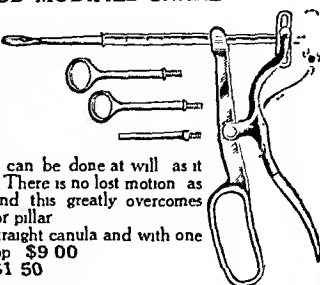
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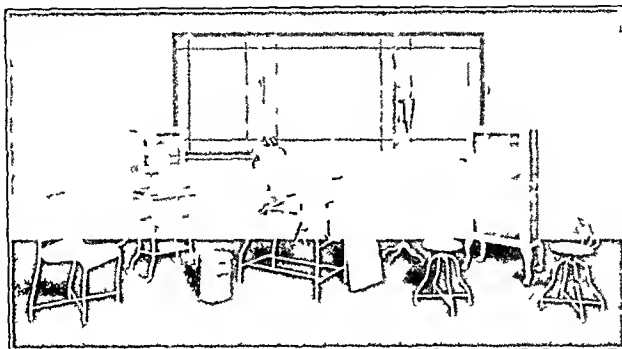
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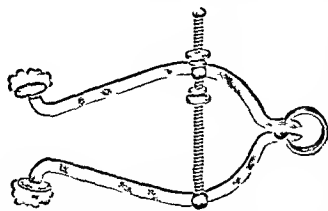
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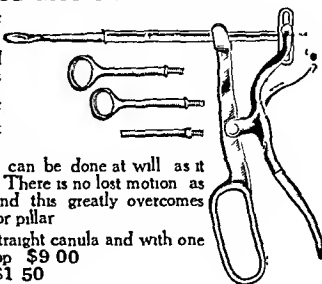
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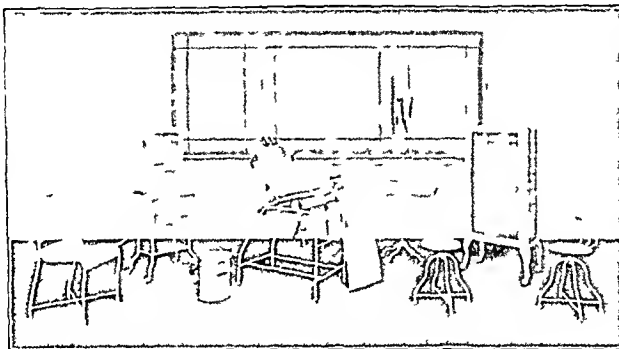
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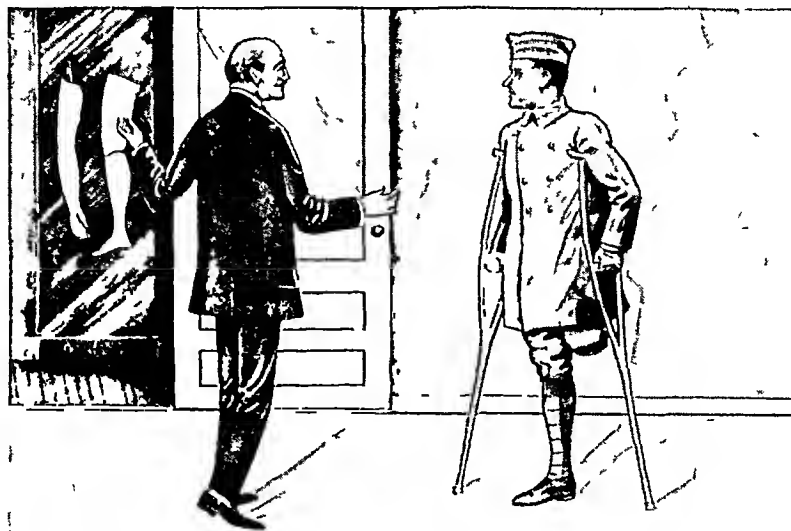
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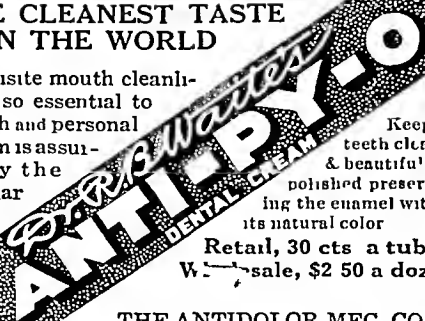
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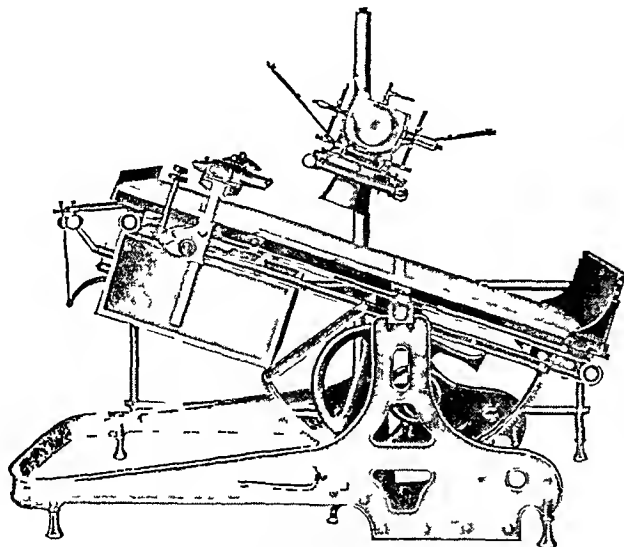


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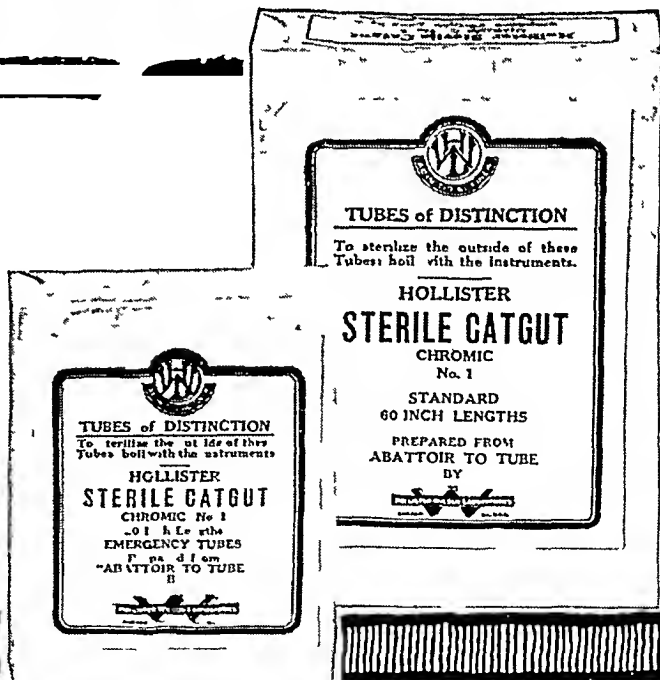
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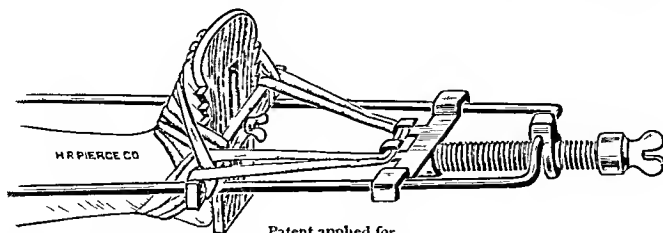
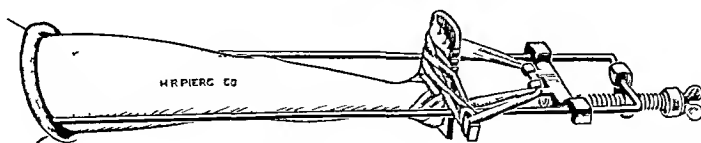


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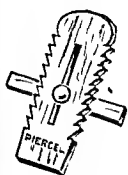


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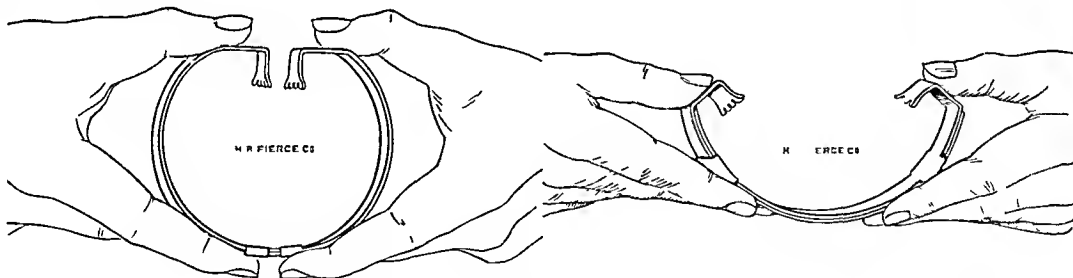
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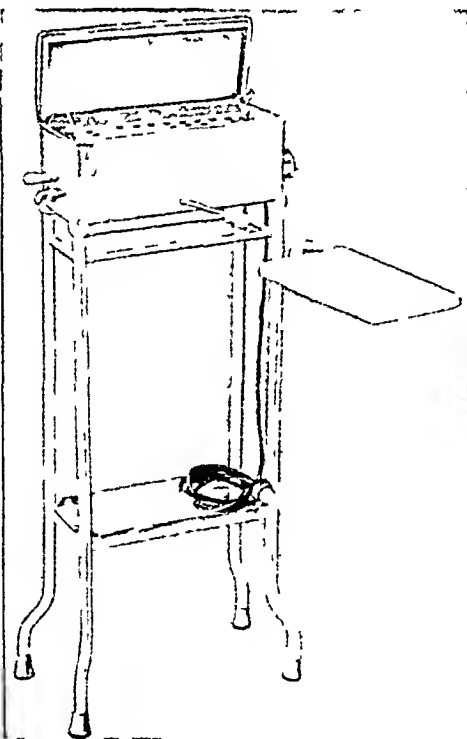
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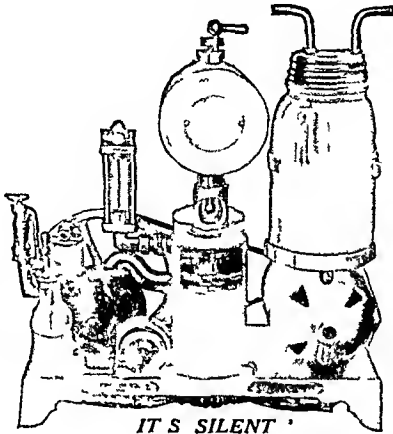
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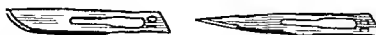
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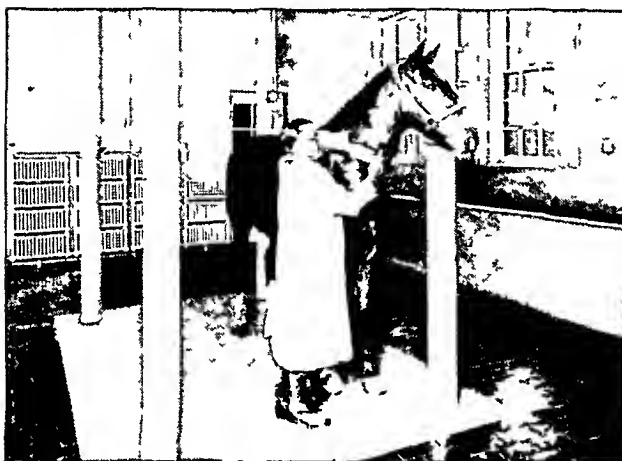
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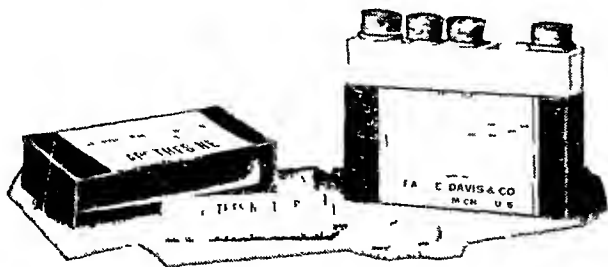
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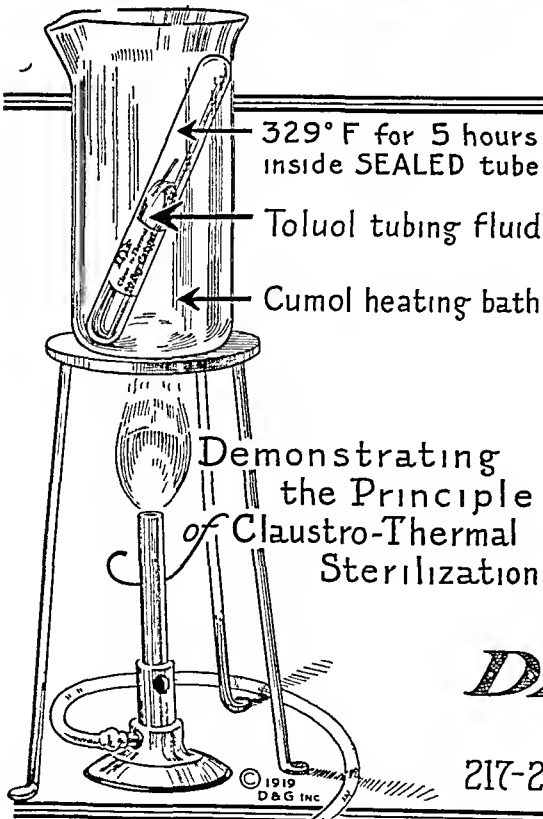
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ANNALS *of* SURGERY

VOL. LXXI

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No. 2

OXYCEPHALY: REPORT OF TWO CASES *

BY STEPHEN H. WATTS, M.D.

OF CHARLOTTESVILLE, VA.

PROFESSOR OF SURGERY, UNIVERSITY OF VIRGINIA

THE various types of cranial deformity associated with optic atrophy have been fairly familiar to the ophthalmologist for a number of years, but if I may judge from my own experience and from the comparatively meagre literature on the subject, the general physician and surgeon is poorly acquainted with this group of cases to which Bertolotti applies the term "cranio-synostose pathologique."

Of these deformities the most frequent and important is the oxycephalic type, also called by various other names, steeple or tower head, Turmschadel, Spitz-kopf, turricephaly, acrocephaly, hypsicephaly, etc. The two names which have been used most frequently and interchangeably are "turmschadel" or steeple head, and oxycephaly, and Sharpe has suggested that we consider the two names as applying to one condition which differs only in the degree of the deformity, turmschadel or steeple head for the mild form of the condition, where there is no definite prominence or protrusion at the anterior fontanelle, and oxycephaly for the more severe cases with a prominence at the anterior fontanelle.

The first case of this character was described by Von Graefe in 1866 and since that time a good many cases have been reported in the ophthalmological journals. Unfortunately, the first and most important symptom is usually the progressive loss of sight, on account of which the patient is sooner or later, usually later, taken to the oculist and generally little or no attention has been paid to the cranial deformity. Since the dimming-of vision usually occurs in early childhood it is often not recognized until the optic atrophy is far advanced, therefore I think it is to be deplored that the family physician and children's doctor are not more familiar with the fact that certain types of cranial deformity are apt to be associated with optic atrophy, as I believe that if X-ray pictures were made of these pathological varieties of skull deformity in early life, a diagnosis could be made in many cases and optic atrophy prevented by an early decompression to relieve the increased intracranial pressure. The importance of oxycephaly as a cause of blindness is shown by the

* Read before the Southern Surgical Association, December 18, 1919

fact that Meltzer was able to report 20 cases of this character from one institution for the blind in Germany

Etiology—Many theories have been advanced to account for the cranial deformity and the associated disturbance of the optic nerve. As regards the cranial deformity it is now generally believed to be due to a premature synostosis of the parietal bones with the occipital and temporal bones, with a compensatory enlargement in the region of the sagittal suture and in the frontal region. The cause of this premature synostosis is not known. It has been attributed by some to rickets but most of the cases have shown no other signs of rickets, no rosary, no enlargement of the epiphyses, no curvatures of the long bones, etc., moreover, in rickets the closure of the sutures is usually delayed and the deformity of the head is different. Of the forty cases in the collective reviews of Enslin and Patry none showed any signs of rickets. Others believe the synostosis is due to irritation of the sutures by a meningitis involving the dura, but there seems to be little to support this theory. Virchow thought that a congested condition of the skull contents without actual inflammation might cause synostosis. Schuller is of the opinion that the premature synostosis is an evidence of a developmental disturbance which shows itself in the skull and not in the rest of the skeleton, but this theory still leaves us ignorant of the primary cause. In one of my cases two years after a bilateral subtemporal decompression the X-ray shows practically complete ossification over the protruding brain, and I have wondered whether the tendency to new bone formation might be of any significance in this connection.

The optic atrophy has been ascribed to meningitis, to local changes in the optic foramina making pressure on the optic nerves, and to the increased intra-cranial pressure. Meningitis can probably be dismissed with few words since, if it were the cause, the other cranial nerves would be more frequently involved. Pressure on the nerves in the region of the optic foramina has been attributed to narrowing of the foramina by distortion or by hyperostosis, but in only one or two cases has autopsy shown any evidence of such narrowing. A few years ago von Behr claimed to have found that in many cases of oxycephaly the distortion of the skull displaces the carotid sulcus forward in such a way that the carotid artery does not lie to the outer side of the nerve but beneath it, and as the artery turns backward in its sagittal course it forms the lower wall of the optic canal, thus compressing the nerve and causing the atrophy. In 1913 Schloffer examined a number of oxycephalic skulls and in many found relations apparently confirming Behr's theory. After practicing the operation on the cadaver he removed the roof of the optic canal, by a two-stage operation, in two cases of oxycephaly with rather advanced optic atrophy, the operation being confined to one side in each case. In one case which was followed only a few weeks there was no change in the eye, but in the other case, after three weeks, light per-

ception returned, a result which had not been accomplished by a previous decompression. He says that further experience only will show whether this operation, which he calls the "Kanal operation," is valuable, but he thinks it may at least be justifiable when a previous decompression has failed.

A number of cases have been reported in which a definite condition of choked disk has been seen preceding the optic atrophy, and most authors believe that the optic nerve changes are due to an increased intracranial pressure, just as they are in cases of cerebral tumor. There has been some difference of opinion regarding the cause of the increased pressure, most observers believing it to be due to the disproportionate growth of the brain and skull, while some, notably Meltzer, Vorschütz, and Bramann, think it is due to an internal hydrocephalus.

Those holding the former view call attention to the fact that owing to the premature synostosis the skull cannot keep pace with the expanding brain, which grows very rapidly in the early years of life, consequently the skull becomes deformed and the constant pressure of the brain causes an atrophy of the skull even to the extent of producing considerable openings in it, "spontaneous decompression."

Meltzer thinks the increased intracranial pressure is due chiefly to internal hydrocephalus, the result of a serous meningitis, but few autopsies have shown any chronic dilatation of the ventricles. Of six cases with autopsy, collected by Schumacher, hydrocephalus was found in only one. In Vorschütz's case the hydrocephalus was due to the cerebellum being jammed in the foramen magnum. Internal hydrocephalus is certainly not constant, in fact, is apparently rare with oxycephaly and, when it does occur, is probably secondary.

Oxycephaly occurs much more frequently in males than in females, the proportion being about 5 to 1, of 17 cases collected by Friedenwald, 15 were males and 2 were females, of the 8 cases of Oberwarth 6 were males. Heredity seems to have little influence, though cases have been reported in two brothers or two sisters.

The mentality is usually unimpaired, in fact, the cases seem unusually bright, considering that they are often handicapped by poor vision or blindness.

Symptoms and Signs—In some cases there are no subjective symptoms, the skull apparently accommodating itself to the growing brain. In many cases there is headache and occasionally there is vomiting and convulsions. When these come on suddenly we might think of the possibility of an internal hydrocephalus. The cardinal signs are (1) the type of cranial deformity, (2) the exophthalmos with strabismus, (3) the impairment of vision.

The cranial deformity is generally very characteristic (Figs 1 and 2). The skull is of unusual height and its apex, just behind the region of the anterior fontanelle, is usually formed by a projection, or crista sagittalis,

corresponding to the sagittal suture. From here the parietal bones drop rather abruptly downward, or there may be a hollow on each side of the crest. The forehead is high and steep. The superciliary ridges, and the temporal ridges and depressions, are feebly marked. The orbits are very high and very shallow. The palate is often high and narrow. The face may be asymmetrical, due usually to a flattening or depression in the malar and submaxillary region.

The Röntgen picture is very striking (Figs 3 and 4). The skull is usually thinned and marked by wave-like depressions, corresponding to the cerebral convolutions. The sutures are usually not seen. The base of the skull is deformed, the middle fossa is deepened so that it is almost on the same level with the posterior fossa, the sella turcica is widened and deepened, the great wings of the sphenoid are flattened out, the roof of the orbit may be almost vertical, the head sinuses are compressed and sometimes practically obliterated.

Exophthalmos with divergent strabismus is nearly always present in the well marked cases, though the strabismus is occasionally convergent. The exophthalmos is due to the very shallow orbits.

Nystagmus is very commonly present, it is usually bilateral and in all directions.

The impairment of vision is marked in nearly all the cases. The cause of this impairment has been discussed above. It may be present at birth but is usually noticed between the second and sixth years of life. It may progress to a certain degree and stop or go on to complete blindness.

The loss of smell is not infrequent. Hearing is sometimes dulled and the sense of taste is occasionally lost.

Oxycephaly may be associated with other congenital anomalies, but this is not strikingly frequent.

Treatment—It is only in recent years that operative measures have been undertaken with the object of combating the symptoms of increased intracranial pressure, especially the threatened blindness.

Since most observers think that this increased pressure is due to the disproportionate growth of the brain and skull, decompression seems to be the operation of choice, moreover, it has the advantage of simplicity and relative safety. It should be done early, for in cases with irreparable optic atrophy and no other pressure symptoms operation is not indicated. The results of this operation in the small number of cases in which it has been done are distinctly encouraging, in spite of the fact that the optic atrophy was rather advanced in most instances. In 1916 Sharpe reported four cases of oxycephaly in which he had done subtemporal decompression, unilateral in one, bilateral in three. The three cases in which the bilateral operation was done were followed and found to be greatly improved, the other case could not be traced.

The case, here reported, in which I did a bilateral subtemporal decompression was seen about two years after this operation. The parents

OXYCEPHALY REPORT OF TWO CASES

stated that his general condition was much better and that he seemed to see better, as he stumbled much less in walking. He could count fingers at three feet, which he could not do before operation. Examination of the eye grounds, however, showed practically no change, there being a marked optic atrophy in both eyes. An interesting feature of this case is that at operation the bulging of the brain was so marked that the temporal fascia could not be at all approximated on either side, therefore the defects were covered by transplanted patches of fascia lata. Another point of interest is the ossification of the tissues over the region of the decompression, this bone showing the same digital impressions as the rest of the skull (Fig 5).

Considering the increased intracranial pressure to be due to internal hydrocephalus, Bramann and others have advised puncture of the corpus callosum in oxycephaly, but, as stated above, internal hydrocephalus seems rarely present in such cases. When doing a decompression we certainly would not omit a ventricular puncture if we have reason to suspect that internal hydrocephalus is present.

The "Kanal operation" of Schloffer does not appeal very strongly to us, but it might be justifiable in certain cases, when a decompression has failed to improve the condition of the optic nerve.

REPORT OF CASES

The first case is a typical case of oxycephaly which was admitted to the University of Virginia Hospital with advanced optic atrophy. The second case is certainly not typical, but I think it is a case of cranial stenosis, probably of the "turmschadel" type. The head is quite tall and the skiagram of the skull shows many of the characteristics of the steeple head skull, but a marked anterior staphyloma in both eyes prevented my examination of the optic disks.

CASE I—T. W., colored male, aged four years, was admitted to the hospital February 11, 1918, complaining of failing vision.

Family History—Father, mother, two sisters, and one brother living and in good health. No history of abnormalities in family.

Previous History—Patient is the third child. His birth was not difficult. Had whooping cough at nine months of age, after which mother thought eyes were more prominent than before.

Present Illness—Four months ago mother noticed that there was some trouble with the patient's sight. He seemed to be constantly running into things. Since then he has been getting worse. Mother says head has always been peculiarly shaped. There has been no headache, no vomiting, no convulsions.

Physical Examination—The boy is well nourished and mentally bright. Head Unusually tall (Figs 1 and 2). Transverse diameter compressed in biparietal region. Forehead very high. Protusion at bregma 4 by 6 cm. in diameter (crista sagittalis). Anterior

and posterior fontanelles firmly closed Supraorbital ridges are almost obliterated

Skigrams of skull (Figs 3 and 4) show all the characteristics of the oxycephalic skull as described above The "digital impressions" are unusually well marked

Cranial Measurements Hat circumference, 48.5 cm, bimeatal arch, 35 cm, chin to nasion, 11 cm, width of orbit, 3.5 cm, height of orbit, 4 cm, inter canthi, 3 cm

Face Symmetrical

Eyes There is marked exophthalmos Left eye shows internal strabismus There is a marked impairment of vision, shown by the fact that he is unable to recognize familiar objects He walks in a wandering fashion with a tendency to feel his way and often stumbles on things The light reflex is present Ophthalmoscopic examination shows marked bilateral optic atrophy

Nose Negro type, flat and wide Septum is deflected Sense of smell normal

Mouth Palate rather high Tonsils very large

Ears Low placed, but normal in shape Hearing normal

Heart, lungs, and abdomen Negative

Extremities Negative No evidence of rickets Motion and sensation normal

No other abnormalities of any kind made out Wassermann test negative

Operation (February 16, 1918) —A bilateral subtemporal decompression was done Temporal muscles very thin The skull was extremely thin, in fact, almost as thin as paper, and at one point on the left side there was a definite opening 5 mm in diameter, due to pressure atrophy Openings the size of a silver dollar were made on each side of the skull and through these openings there was a very marked protrusion of dura and brain The dura was not opened An attempt was made to suture the temporal fascia but it could not be brought together, so patches of fascia lata 4 to 5 cm in diameter were transplanted to cover defects and sutured with fine silk The wounds healed per primam and patient made an uninterrupted recovery from operation

He returned for examination on December 5, 1919 Mother says his general condition is much better and she thinks he can see better, as he stumbles much less in walking

He can count fingers at three feet with the right eye and with the left eye he can see movements of the hand at three feet, which is a distinct improvement over vision before operation, but examination of the eye grounds shows no improvement There is advanced optic atrophy, the disks being white and indistinct in outline

Examination of head shows protrusions, 6 cm in diameter and 1 cm high, in region of decompression Protrusions are covered with bone as shown by X-ray photograph (Fig 5)

CASE II —T A, colored female, aged about four years, was ad-



FIG 1—Case I Note very tall, narrow head Exophthalmos



FIG 2—Case I Lateral view Protrusion at bregma Relatively short face



FIG 3 —Case I Anterior posterior skiagram Note thin skull and digital impressions



FIG 4 —Case I Lateral sknagram Note deep middle fossa shallow orbits and obliteration of mastoid and frontal sinuses



FIG 5 —Case I Two years after subtemporal decompression Note ossification over decompressions

OXYCEPHALY REPORT OF TWO CASES

mitted to the University of Virginia Hospital, September 23, 1919, complaining of sore eyes and loss of sight

Family History—Father living and well Mother has had "epileptiform attacks" for eight to ten years No brothers or sisters

Previous History—Mother had a very stormy time at patient's birth, was in labor for several days and was delivered with forceps No disease of childhood except whooping cough

Present Illness—Several days after birth mother noticed "corruption" in child's eyes and some days later she noticed a whitish covering over the eyes This opacity and the bulging of the eyes have gradually grown worse and about five months ago the left eye "burst" Mother has not noticed any peculiarity in the shape of the head There has been no headache, no vomiting, and no convulsions

Physical Examination.—Child is fairly well nourished Mentality is good, especially considering the deprivation of vision

Head The tall head and high forehead are striking, but there is no protrusion at the bregma The union of the cranial sutures is apparently normal No ridges along cranial sutures The supra-orbital ridges, and the temporal ridges and depressions, are feebly marked

Skiagrams of skull show it to be unusually thick and "digital impressions" are not marked except in lower portion of the parietal and in the temporal bones, but middle fossa is wide and deep and is only slightly above the level of the posterior fossa The head sinuses are almost obliterated The orbits are high and shallow

Cranial Measurements Hat circumference, 48 cm, bimeatal arch, 34.5 cm, biparietal diameter, 13 cm, bitemporal diameter, 12.5 cm, width of orbit, 3.1 cm; height of orbit, 3 cm

Face Symmetrical, comparatively small for the cranium

Eyes Slight exophthalmos is noted with divergent strabismus, more marked in left eye Nystagmus is present, bilateral and in all directions

Owing to the anterior staphyloma, resulting from gonorrhoeal ophthalmia, examination of the eye grounds is rendered impossible and we cannot determine whether optic atrophy is present Vision in both eyes is practically destroyed, large objects, light and dark, only being perceived

Nose Negro type Septum not deflected Sense of smell normal

Ears Placed very low but normal in shape Hearing normal

Mouth Palate quite high and narrow

Heart, lungs, and abdomen Negative

Extremities Negative No evidence of rickets Motion and sensation normal No other abnormalities of any kind made out Wassermann test negative

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THE SURGICAL TREATMENT OF CYSTS OF THE THYROGLOSSAL TRACT

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MAYO CLINIC

VERY early in fetal life the thyroid gland develops at the base of the tongue and, before the cartilage of the hyoid bone has formed, descends in the midline of the neck to its normal position. The epithelium lining this tract through which the thyroid descends normally disappears early in fetal life, although it occasionally fails to obliterate and in such instances isolated areas of thyroid tissue (aberrant thyroids) or cysts may develop along its course. It seems quite likely that the portion of the tract lying above the hyoid bone often retains its epithelium and patency and opens directly into the mouth through the foramen cæcum near the base of the tongue. A persistence of this portion of the duct explains the development of cysts along this tract which do not appear in young children but are first noticed a number of years after birth. In such instances it is probable that any secretion which developed from the epithelium-lined tract emptied directly into the mouth through the foramen cæcum, and that at some time infection occurred in the duct and closed the opening into the foramen cæcum. Any fluid accumulating in this duct after the opening in the foramen cæcum has become blocked, most likely travels downward, following the tract made by the descending thyroid, and presents itself as a tumor in the midline of the neck near the hyoid bone.

In 86,000 consecutive patients examined in the Mayo Clinic only 31 thyroglossal cysts were found. Eighteen of these were in males and 13 in females. The cysts appeared at all ages from birth to fifty-three years, the majority being noted in patients between the ages of twenty and twenty-five years. In 25 of these patients the cyst was found in the midline of the neck, near the hyoid bone.

The diagnosis of such cysts is usually not difficult and is made by the finding of a rather firm, cystic tumor in the midline of the neck, near the hyoid bone or the thyroid cartilage. When this is palpated the duct which runs from the cyst to the hyoid bone may usually be felt. If the cyst is left alone, it gradually enlarges and often is drained surgically. In other cases infection occurs within the cyst and an abscess forms which also is often opened and drained. In either case a sinus remains which discharges the fluid secreted by the epithelium lining the tract. In many of the patients whom we have examined fistulas have been present which had persisted for periods varying from six months to twenty-nine years.

The majority of operations for the cure of thyroglossal cysts are unsuccessful unless the epithelium-lined tract, running from the cyst to the foramen cæcum, is completely removed. As a rule, the cyst and the portion of the tract lying below the hyoid may be dissected out without difficulty, but above this the tract is usually so small and friable that it is broken off easily and consequently is difficult to remove. We have learned, after having failed to cure certain patients in whom the duct was broken off between the hyoid bone and the foramen cæcum, that better results are obtained when no attempt is made to isolate the duct above the hyoid bone. Instead of attempting this, the usual procedure, we remove with the duct the tissues surrounding it for a distance of about one-eighth of an inch on all sides, coring out, as it were, the tissues between the hyoid bone and the foramen cæcum in a line, which the tract almost invariably follows, drawn at an angle of forty-five degrees from the upper surface of the centre of the hyoid bone in the midline of the neck, backward and upward, toward the base of the tongue (Figs 1 and 2).

The operation we usually perform is as follows. A transverse incision, about two inches in length, is made across the neck at about the level of the hyoid bone and the skin and platysma muscle are reflected. The cyst will be found lying beneath the raphé connecting the sternohyoid muscles. It is dissected free from the surrounding tissues up to the hyoid bone. At this point the tract usually passes through the hyoid bone, although it is sometimes found passing above or below it. We then separate the muscles attached to the centre of the hyoid and remove a portion of the bone about one-fourth of an inch in length, then, without any attempt to isolate the duct, we core through the tissues from this point directly to the foramen cæcum, removing with the duct the tissues surrounding it for a distance of about one-eighth of an inch on every side (Fig 3). In order to do this, it is necessary to know very accurately the direction that must be followed in order to reach the foramen cæcum. This line corresponds to one drawn at an angle of forty-five degrees backward and upward through the intersection of lines drawn horizontal and perpendicular to the superior central portion of the hyoid bone. The dissection removes with the duct a portion of the hyoid bone, a portion of the raphé joining the mylohyoid muscles, a portion of each geniohyoglossus muscle, and the foramen cæcum. The opening into the mouth is closed and several sutures are used to draw the geniohyoglossus muscles together, the tissues surrounding the cut ends of the hyoid bone are then brought together with chromic catgut sutures in such a manner as to approximate the edges of the bone. A small rubber tissue drain is introduced down to this point and the skin closed around it. It is probably best to inject sinuses with some dye, such as methylene blue, in order that any lateral branches, and these are occasionally found, which may be present between the hyoid bone and the foramen cæcum may be recognized and removed. We have never seen ill effects follow the removal of a portion of the hyoid bone, nor have we ever seen infection of a serious character follow the opening made into the mouth.

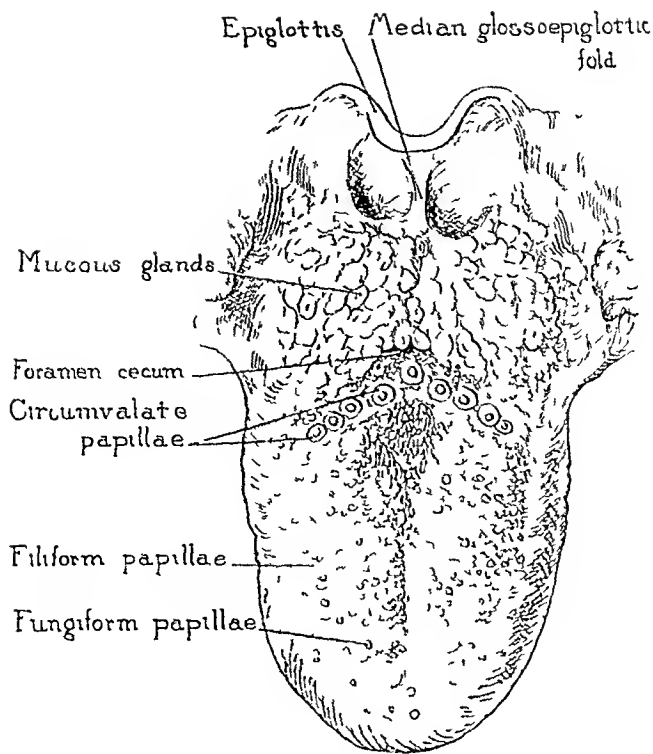


FIG 1 —Anatomy of the dorsal surface of the tongue and the position of the foramen cecum

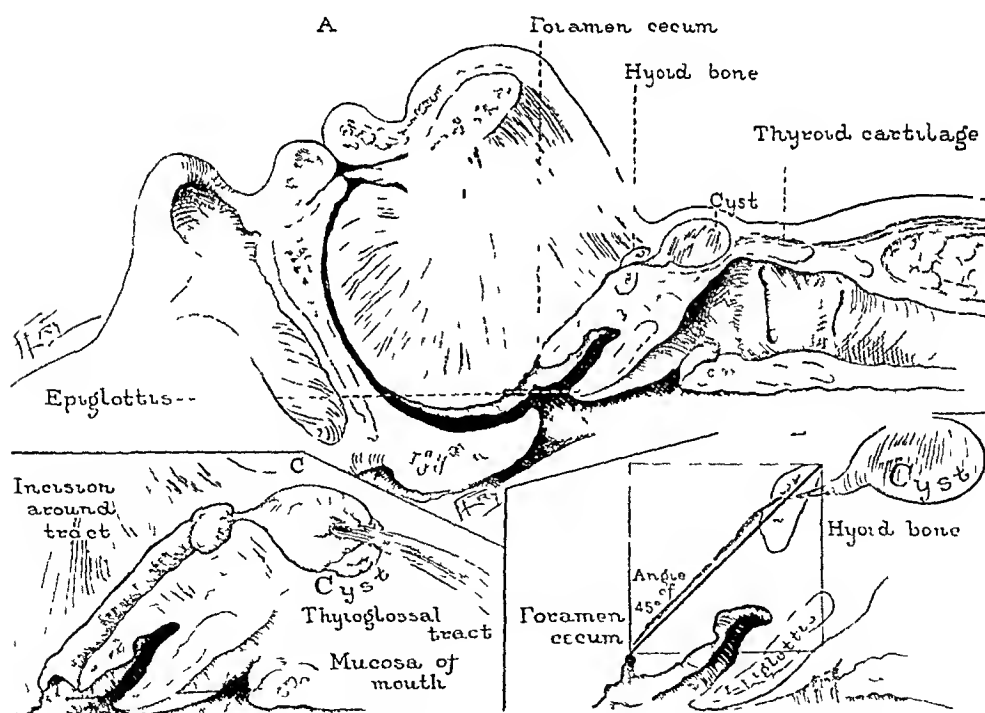


FIG 2 — 1 Sagittal section of the head giving the usual direction of the thyroglossal tract. The cyst is shown presenting between hyoid bone and thyroid cartilage. B Dissection of duct to be made along an imaginary line drawn at an angle of 45° from the intersection of lines drawn horizontal and perpendicular to the middle of the anterior superior portion of the hyoid. C The duct with muscles surrounding it being 'cored out' along the line shown.

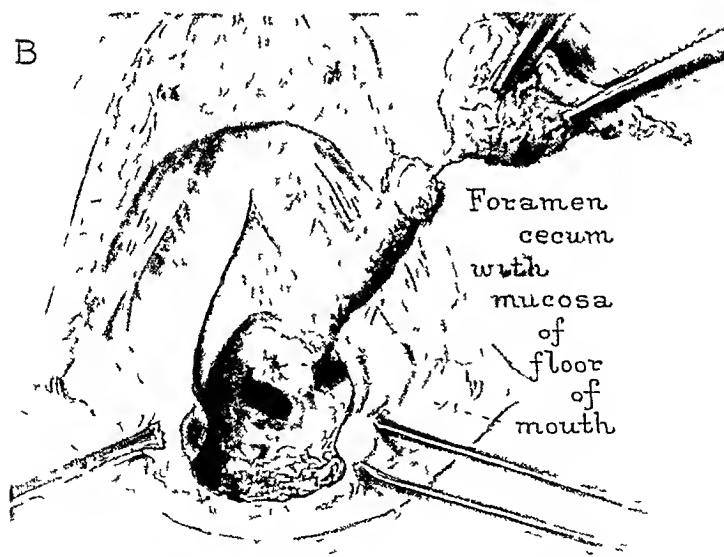
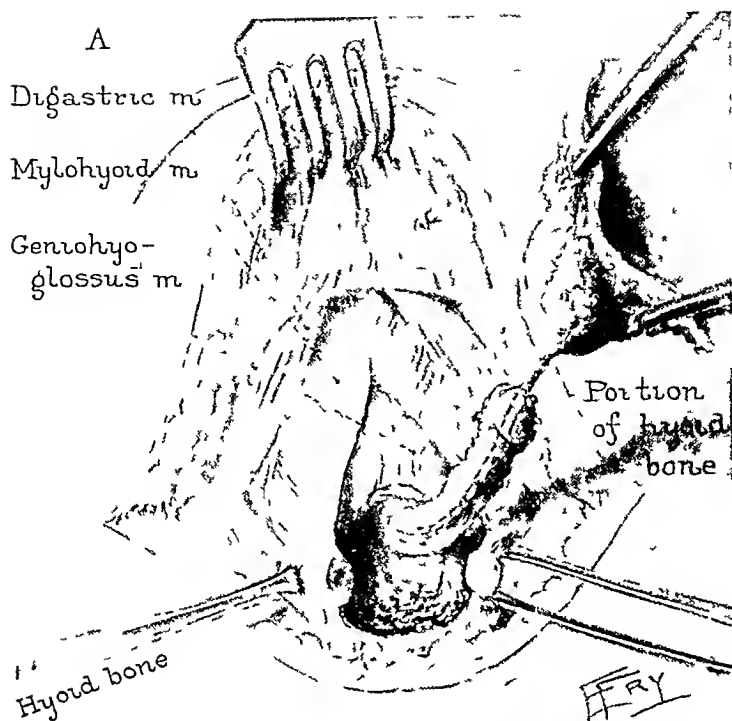


FIG 3—Steps of the operation. A A segment of hyoid has been removed and the duct with the surrounding tissues is being dissected out. B The dissection has been extended through the tongue, the foramen cæcum may be seen.

STONE IN THE KIDNEY *

By CHARLES H MAYO, M D
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IN medical progress the means of relief by therapeutic measures or surgery have far outstripped our knowledge of the cause of disease. The etiology had been proved in a sufficient number of instances, however, and reasoning by analogy in other diseases had led to measures of prevention and control of many of the common ailments before the identity of the bacterial agents was known. Medicine is in its most interesting phase, namely, a consideration of the etiology which carries investigation into the field of biochemistry, the newer physiology, and like sciences. The philosophic view of bacteria is to consider them necessary to life as the minute chemists of the air, the water, and the soil. But few of their countless numbers are the cause of disease by being misplaced in their activity and only a small number, possibly, are natural disease-creating organisms.

THE FORMATION OF STONE IN THE KIDNEY

Crystalloids probably form in the structure of the kidney, the cortex, and the surface, without local infection, the result of a rare unbalanced contest constantly ensuing between crystalloids and colloids. Stones in the kidney, ureter, or bladder undoubtedly originate in the kidney, except those which develop from foreign bodies in the bladder. The cause of stone in the kidney has long been a subject of discussion, the old and simple theory that they grew like Topsy, is no longer satisfactory, and some of the other theories that have been advanced, although most interesting, are not generally accepted. An acceptable scheme of stone formation must be applicable to the several regions in which stones are found and it must not differ materially for any locality. Morris considers two types of stone, the first due to urinary salts or ingredients precipitated from the urine in the kidney, independent of any change in that structure or of infection, and the second, to precipitation due to chemical changes caused by microorganisms. An analysis of stones in the Hunterian Museum has shown a urate nucleus in stones formed in infancy, a uric acid nucleus in stones removed from young adults, and an oxalate nucleus in stones removed from patients in middle life.

Two-thirds of the kidney stones giving trouble are found in patients in the third and fourth decades, although the stones appear in every decade of life. Certain observers hold to the theory that a slowing of the delivery of urine in limited areas leads to increased concentration and deposit of salts. In denying the infection theory they call attention to

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the fact that renal stones are more often found in men than in women, although the female genito-urinary tract is more likely to be infected. According to their theory, therefore, an increased number of stones should form following mechanical interferences in areas of the pelvis with the passing of urine, such as partial ureteral obstruction, and extraneous pressure, glands, tumors, or pregnancy, for instance, but this does not appear to be the case. Hunner's theory is not generally accepted, that the over-saturated urine forms stones which originate in the ureter above a stricture of large calibre and may float back into the pelvis of the kidney. It is barely possible that the infection causing stricture may be furnishing mucoid, the cause of stone formation in such a condition. If these hypotheses were true, the number of cases of stone from such causes would be greatly added to by the partial compression of anomalous vessels acting on the ureteropelvic juncture in unusual mobility of the kidney, first shown by W J Mayo and later by Rupert to be a very common condition.

Stones are frequently found in both kidneys. Braasch found bilateral lithiasis in 12.3 per cent of 450 cases of nephrolithiasis. Many patients with stone in the kidney have no pain, and 65 per cent with stones in both kidneys have pain on one side only. Cabot, by means of repeated tests, showed that there are no abnormal urinary findings in 14 per cent of the cases of stones in the kidney and ureter. The kidney is an organ of filtration and is constantly eliminating bacteria from the circulation. These are many in variety and, without some contributing circumstances, apparently do not injure the urinary tract in their passage through the kidney, ureter, and bladder any more than bacteria on the skin or those passing through the alimentary tract or normally living there cause trouble in those regions. Some types of bacteria produce infarctions in minute clumps of capillaries, and following surgical conditions gross kidney infarctions and infection which cause death are occasionally seen. The minute hæmatogenous infections at the boundary of the terminal circulation in the cortex of the kidney at its juncture with the tubules are seldom extensive enough to create more of a change in the patient's general health than an acne pustule on the face. The eliminating surface of the kidneys probably equals that of the skin covering the body, but the latter has the power of cell growth given to epithelium for restoration as an additional protection. The infection theory seems the only tenable one, but I contend that the development of stone requires the presence of two factors of infection, that is, two types of bacteria, one producing the hæmatogenous infection, and one only coming from a local focus, the second may but temporarily inhabit the blood in the process of elimination. Bacteria of the stone-forming type must come in contact at the proper time, a brief period only, in which the mucoid exudate is present as a result of the first infection.

It seems hardly possible that the lime content of food or drink, which



FIG 1 —Infected hydronephrosis with multiple nephrolithiasis

Calices contain pieces broken from large stone



FIG 3 —Coral shaped stone with hydronephrosis of the kidney



FIG 2 —Hydronephrosis with oval stone

STONE IN THE KIDNEY

it must be admitted varies greatly, has very much to do with the origin of stone, although it might influence the rapidity of the growth of the stone. The origin of stone in the kidney is no more mysterious than that of stone on the teeth of infected mouths, which requires a chisel and hammer for removal, saliva resembles the mucoid, giving foothold through diseased gums for types of bacteria of the proper strain, and stone formation ensues, this is true also in the development of gall-stones, which form only in an infected gall-bladder. A step further is the development of the shells of the fresh and salt water mollusks. We think of them as having been built by the mollusk, in reality they are built by bacteria feeding on the pabulum of his exuded mucoid material, according to which the natural type of shell is constructed from the solutions held in the water of the sea or river, the bacteria doing the work for bed and board, the mollusk furnishing the muscle hinge. If these bacteria become misplaced within his body a pearl or slug develops as the result of his disease. Such life can be reproduced only in limited areas of sea or river beds where the bacteria grow in great numbers, producing clam and oyster beds. The work done by such bacteria is no more important than that of the insects which fertilize the fruit flowers.

Stones form in the cortex, in the calyces, and in the pelvis of the kidney. The kidney is constantly eliminating living bacteria, so that it is always exposed to infection, and usually shows no results from it except gross lesions of rare occurrence. Stone formation may proceed with exceeding slowness and without pain or other symptoms until marked destruction of the kidney occurs, mixed infection develops, or until the stone assumes great size or becomes loosened and moves into the ureter (Fig 1). Minute infarctions occur, as shown at necropsy following death from an acute attack, and the results of similar lesions in the past are shown by scars or gross kidney change.

Stone formation is evidently the result of the combination of two types of bacteria, the first creates an infarction with minute necrosis causing mucoid exudate, the second factor is the elimination at the same time of the stone-forming bacteria that they may come in contact with the mucoid material. If the stone originates in the cortex of the kidney its growth will be slow, but if it originates in the calyces or pelvis growth may be much more rapid because of the ease with which its chemical material is secured.

Stones in the kidney vary in chemical composition but are homogeneous, they are round, irregular, multiple or branched, coral-like (Figs 2 and 3). Those forming or increasing in the urinary bladder often form rings of varying widths, as shown by cross-section. During growth stones are covered with mucous and the changes in structure probably have to do with the mucoid material on the stone or changes in the metabolic process, so that the structure varies with changes in the number of the workmen or the material supplied them. Bacterial types differ

in their handling of material as much as masons differ in the use of brick, stone, and cement. It is of interest to note that young oysters transplanted from the shores of England to the Mediterranean oyster beds will have the ray shells formed by the new bacterial architects (see bibliography, Turnbull), a fact of importance in considering branched coral-like stones in the kidney. Medical treatment in principle is based on a change in the chemical conditions of urine or local environment created by food changes, by dilutions, or by elimination of various chemical bacterial detritus. In the review of a limited number of cases in which operation was done during the formative period of surgery of the kidney Cabot found that stone in the kidney reformed in 49 per cent, stone in the ureter in 29 per cent. Braasch, in a consideration of 450 cases of stone in the kidney in which operation was performed, showed that the recurrence was slightly under 10 per cent. We believe that this better result is due to more careful examinations made within the last few years, to the greater facilities for all kinds of tests, including roentgenography, especially after operation, in order to discover whether or not a stone has been overlooked, the roentgenogram occasionally shows surprising results in cases of small multiple stones. More careful search must be made for extra stones, since superimposed stones may give but one shadow.

The mortality is low in operations for the removal of stone in the kidney. The reports from the clinic (Table I) show that the mortality percentage has risen during the past three years over that of the years from January 1, 1898, to December 31, 1915, this is no doubt due to the greater risks which have been taken, but which have resulted in the saving of an increased number of lives.

TABLE I

Results of the Removal of Stones from the Kidney

	Number of patients	Number of operations	Deaths
January 1, 1898, to December 31, 1915	450	484	3 (62 per cent)
January 1, 1916, to December 1, 1919	487	499	8 (16 per cent)
	<hr/> 937	<hr/> 983	<hr/> 11 (112 per cent)

In closing, I wish to call attention to a plan devised by Doctor Braasch and Doctor Carman of the clinic to prevent overlooking stones in the kidney at operation and to facilitate search for small stones giving symptoms that are difficult to locate in the pelvis, the calices, or the cortex of the kidney. In the course of the operation the kidney is elevated into the incision, above the level of the skin if possible, where it is held by an encircling pack of gauze, a portable X-ray apparatus of the army type is moved to the side of the operating table and under the darkened glass and hood the roentgenologist is at once enabled to locate the stone and to point out the location with an aseptic glass rod, or, what is just as

STONE IN THE KIDNEY

important, and occasionally occurs, he proves that the shadow seen in the rontgenogram was not due to stone in the kidney, and thus prevents serious injury to the organ by a fruitless search. The rontgenologist wears darkened glasses for fifteen minutes before attempting such an inspection. The operating room is darkened and the operator works under electric light which can be turned off and on.

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THE RESULTS OF OPERATIONS FOR THE REMOVAL OF STONES FROM THE URETER^{*}

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WITHIN the past few years many ingenious non-surgical methods for the removal of stones from the ureter have been devised and described, thus greatly reducing the need for operation in these cases. It is first to be desired in cases of stone in the ureter that the stone shall pass voluntarily into the bladder. In some instances this will occur during the first attack of pain, although usually several attacks are required to force the calculus through. Without special investigation of this subject it may not be realized how many persons pass stones spontaneously. I have known of 12 per cent of a group of about 400 persons to respond in the affirmative when they were questioned with regard to the passing of stones.

The published data and our own experience seem to show that most of these calculi originate in the calyces and in the kidney pelvis. In some of the cases in which there is an associated stricture of the ureter the stone may originate at the point of the stricture, as suggested by Rovsing and Hunner, in most of our cases, however, in which a definite, firm stricture was found there was no evidence of a calculus.

The symptoms produced by ureteral calculi are usually very definite and suggest the condition, even though in a number of cases the stone may lie in the ureter for a long time without any apparent changes or symptoms. In several such cases we have not seen changes of any consequence in the ureter or the kidney, nor evidence of interference with the passage of urine. In by far the larger number of cases the characteristic symptoms are manifest, but the syndrome must not be depended on for the diagnosis, since it may be misleading, a variety of other conditions may produce nearly the same syndrome and, furthermore, an accurate and dependable diagnosis can be made in nearly every case by the use of the X-ray combined with the opaque catheter and ureterogram, and in some cases the wax-tip catheter. In doubtful cases in which it is necessary to exclude the possibility of the X-ray shadow which is being produced by an extra-ureteral structure, Doctor Braasch employs ureterograms, and by this method has reduced the possibility of error to an inconsiderable degree.

When the diagnosis has been made and the exact location of the stone is determined there are several points to be considered regarding the plan to follow. We must first remember that in many cases the

^{*} Read before the Southern Surgical Association, December, 1919

stones will pass of their own accord, so that if the patient is having frequent and severe attacks of pain it will probably be best to keep him under observation for a reasonable length of time in the hope that the stone may pass unassisted. During this waiting period, however, the possibility of too severe pressure in the ureter and kidney and of a permanent hydronephrosis or pyelonephrosis should constantly be kept in mind in order that this waiting time shall not be too prolonged. In cases in which the stone apparently is not causing symptoms, even when it is discovered in the course of a routine examination, its removal is advisable unless there is some contra-indication. In all the cases in which the stone does not pass readily of its own accord it is best to consider the non-operative methods of treatment.

Patients with stone in the ureter who come to the clinic for treatment are seen and examined in the department of urology. After the diagnosis has been made the non-operative methods are employed. Braasch, who has removed about 126 calculi in this manner, dislodges the impacted calculus by a ureteral catheter or a small sound. His results have been very satisfactory, and he believes that all patients should have the benefit of an attempt to remove the stones without operation. Braasch's definite contra-indications to further attempts to dislodge stones are (1) A stone 2 cm. or more in diameter, (2) acute ossification with continuous obstruction, (3) acute renal infection, (4) the patient's intolerance to cystoscopic manipulation, and (5) anatomic deformity. If the renal infection is severe intra-ureteral methods should not be attempted, and the operation should be undertaken with the idea that it may be necessary to remove the kidney.

The results of non-operative methods depend largely on the manner in which they are used. Braasch has obtained excellent results by dislodging stones with ureteral catheters and he has also had some good results with papaverin. In nearly all the cases in which the stone presents at the ureteral orifice he has succeeded in removing it by means of the Bransford Lewis and other types of instruments. It is difficult to decide just how many times these non-operative measures should be repeated, the success of the attempt and the pain and discomfort to the patient may well be deciding factors. In some cases, undoubtedly, such treatments have been carried too far, producing infection in a normal kidney, and considerable trauma to the ureter and bladder. It should be borne in mind that while this non-operative treatment was being perfected many improvements were made in the surgical treatment, and the results of operative procedures are now very satisfactory.

A stone lodged in the ureter may result in pathologic changes in several different tissues. In many cases the ureter is dilated above the stone and in some instances this dilatation is marked, so that the ureter seems almost as large as the small intestine. In such cases the wall of the ureter is thick, with definite signs of inflammation. At times the stone com-

pletely blocks the ureter and there is an accompanying hydronephrosis. Unless the kidney is extensively infected it need not necessarily be removed, since after the stone is removed sufficient renal function may remain to warrant saving the kidney. The same condition may result whether the stone is large or small. Contrary to this is the case in which the ureter, on exposure, appears normal in size and appearance, a condition noted in many of our cases. The stone seems almost to fill the lumen of the ureter, and yet there is no dilatation and no evidence to show that the ureter has previously been dilated. The improbability that these stones descend through the apparently normal ureters seems to be evidence of the fact that some of these calculi may form in the ureter itself, possibly at the site of a stricture. This type of stone is small and it is often difficult to locate it in a seemingly normal ureter. It is undoubtedly true that stricture of the ureter occurs in association with stone, and it is quite probable that in some of our cases in which there was not immediate complete relief of symptoms after the stone was removed a stricture caused the trouble. I have been impressed with the infrequency of any gross evidence of a stricture. Even in cases in which difficulty was experienced in removing an inaccessible stone and in those in which the stone had perforated the ureter and produced much peri-ureteral infection we have not seen a stricture of any consequence. In some of our cases there was delay in the closure of the urinary sinus, but in all the sinus was completely closed within a few weeks, and no permanent fistulas occurred. There must have been stricture in some of our cases, but I believe that in most instances the condition relieves itself.

The same conditions follow the removal of stone by the non-operative and the operative methods. In several cases we have found the ureteral calculus lying in an abscess cavity outside the ureter, and in all of these the condition was relieved by the removal of the stone from the abscess pocket and drainage of the abscess without any endeavor to manipulate the ureter. If a pyelonephritis has resulted from the stone and there is evidence of more or less general infection it is inadvisable, if there is a good functioning kidney on the opposite side, to remove the stone and establish drainage. In many of these cases the damage to the kidney is already beyond recovery, the immediate results will not be satisfactory, and the kidney will have to be removed later. In the extreme case, if the stone is in the lower third of the ureter so that a very large incision, or in some instances two incisions, would be required to remove the kidney and the ureteral stone, it is best to remove the kidney and leave the ureter and stone, removing the stone later if necessary. In two of our cases we were obliged to remove the calculus from the ureter at a later date because of pain. Before operation it may be impossible to determine the amount of function in the affected side, as it is sometimes impossible to collect the urine because of the presence of the stone. In these cases I believe the best plan is to remove the stone and preserve the kidney if

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we are not aware of infection in the kidney at the time. Conservative methods are justified in any case of chronic infection of the kidney, but radical methods must be employed in acute severe infection, and nephrectomy should be done before severe uræmia and toxæmia threaten.

In two of our cases complete anuria was produced by stone in the ureter. In Case I (A195194) the patient had been operated on by Dr W J Mayo five weeks before for hypernephroma of the left kidney. The patient made an uneventful recovery from the nephrectomy, was discharged from the hospital, and was about to leave for home when he noticed that his urine had diminished greatly. He told of having passed stones, probably from the right side, some time before, and of having colic, which suggested a stone on the right side. Finally the urine stopped completely and treatment was instituted for suppression, but aside from the fact that there was a little evidence of œdema the patient did not appear to be sick. Doctor Cienshaw catheterized the right ureter and met an obstruction about 5 inches from the bladder which the X-ray showed to be a stone. The patient had passed no urine for six days when I operated, removing the stone from his right ureter. The ureter was greatly dilated and filled with turbid urine. The kidney started to functionate apparently as soon as the pressure was relieved, a large amount of urine was secreted, and the patient made a complete recovery.

In Case II (A205789) the man gave a history of having been operated on several months before for stone in the left ureter. He came to the clinic because of a persistent urinary sinus through the scar on the left side. Doctor Braasch's examination revealed a stone in the right ureter about 6 inches from the bladder, and a ureteral catheter was passed to the scar of the operation on the left ureter. The patient was passing about equal amounts of urine from the bladder and the sinus in the left flank. Shortly after the examination the urine stopped completely. We tried again to probe the urinary sinus on the left side but were not successful. For six days there was no urine passing from the sinus or the bladder and yet the patient apparently was having no trouble because of it. I then removed a stone from the right ureter which was greatly dilated and filled with turbid urine as in Case I. Because of the evident infection no effort was made to close the opening in the ureter and the urine drained for several days, after which the wound healed completely. At this time the sinus on the left side, which we had not been able to open with a probe, opened spontaneously and drained urine. A month after removing the stone from the right side, I operated through the scar on the left side, and closed the left ureter, which was greatly scarred and thickened. Examination of the ureter revealed no cause for the persistent sinus and trouble except extension of scar tissue and stricturing. I excised much of the scar tissue and reconstructed the ureter over a small tube, which was pushed down the ureter so that it projected into the bladder. The tube was removed some days later by means of the

cystoscope The sinus did not reform and the ureter was patent at the time the patient was discharged

The most striking feature in both these cases is that, in spite of the fact that no urine escaped for six days, the patients did not appear to be sick

In our few cases of bilateral ureteral calculi, it has seemed best to remove the stones by operation rather than by non-operative methods We usually operate on one side at a time, although in some instances we have removed stones from both ureters at one operation The side showing evidence of acute trouble is operated on first, if there is no apparent difference we prefer to remove the stone from the ureter on the side having the best function

The cases in which operation has been done between the years 1901 and 1918 are tabulated in Tables I to XIV During this same time, Doctor Braasch has removed ureteral stones in about 126 cases by non-operative methods During the same period we operated on 400 patients In our earlier cases no attempt was made to remove the stone by non-operative methods We find it is difficult to estimate just what percentage of ureteral calculi may be removed by non-operative methods, but probably the percentage is often given too high Roughly estimated, I should say that at the present time about one-half the patients require operation in order to rid them of the stone, in other words, they will be better off if the stone is removed by operation

Forty-eight (12 per cent) of the 400 patients operated on had passed stones or gravel before operation, in 9 cases multiple stones, averaging 6, had been passed, but in all these cases impaction of a stone in the ureter necessitated operation

The diagnosis of ureteral stone by X-ray and cystoscopy has been developed almost altogether since 1901, so that a much higher percentage of accuracy in diagnosis will be found in the later cases than in the cases of earlier years

Our study shows that the results of operations for the removal of stone in the ureter have been almost universally satisfactory Of this series of 400, two of the patients operated on have died and only one of these deaths could be attributed to the operation In the first case an infected appendix was removed, the patient had a left hydronephrosis and a right-sided nephritis, he died of peritonitis In the second case death resulted at about the end of two weeks from infection and extravasation of urine

Convalescence following the operation is usually short and not attended by any difficulties In some instances the urine drains freely for several days, and in others, even though the opening in the ureter has not been closed, there will be very little, if any, drainage In the non-infected cases in which it is feasible to close the opening in the ureter, the wound heals primarily

During the past few months Doctor Scholl has made a careful review

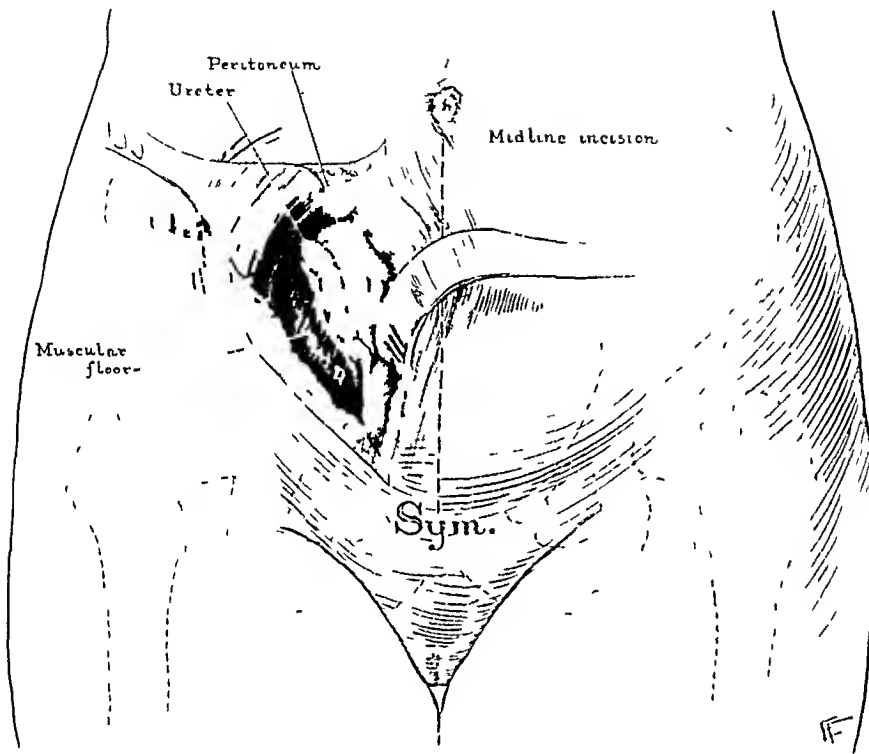


FIG 1 —The midline incision is used when it is necessary to explore both ureters

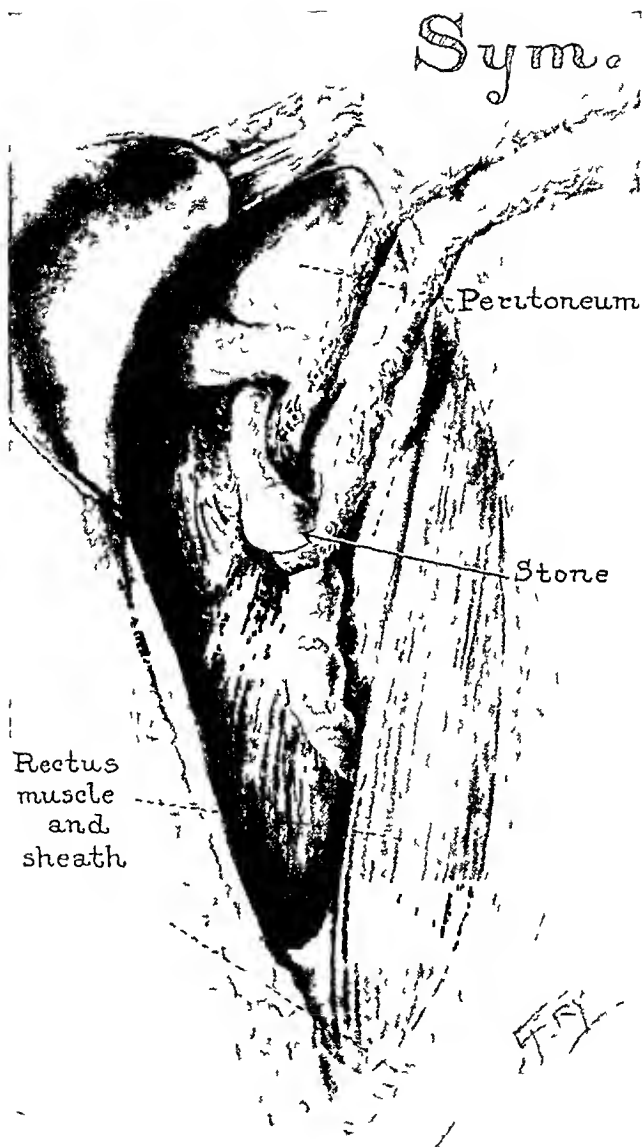


FIG 2 —Isolated ureter containing a stone

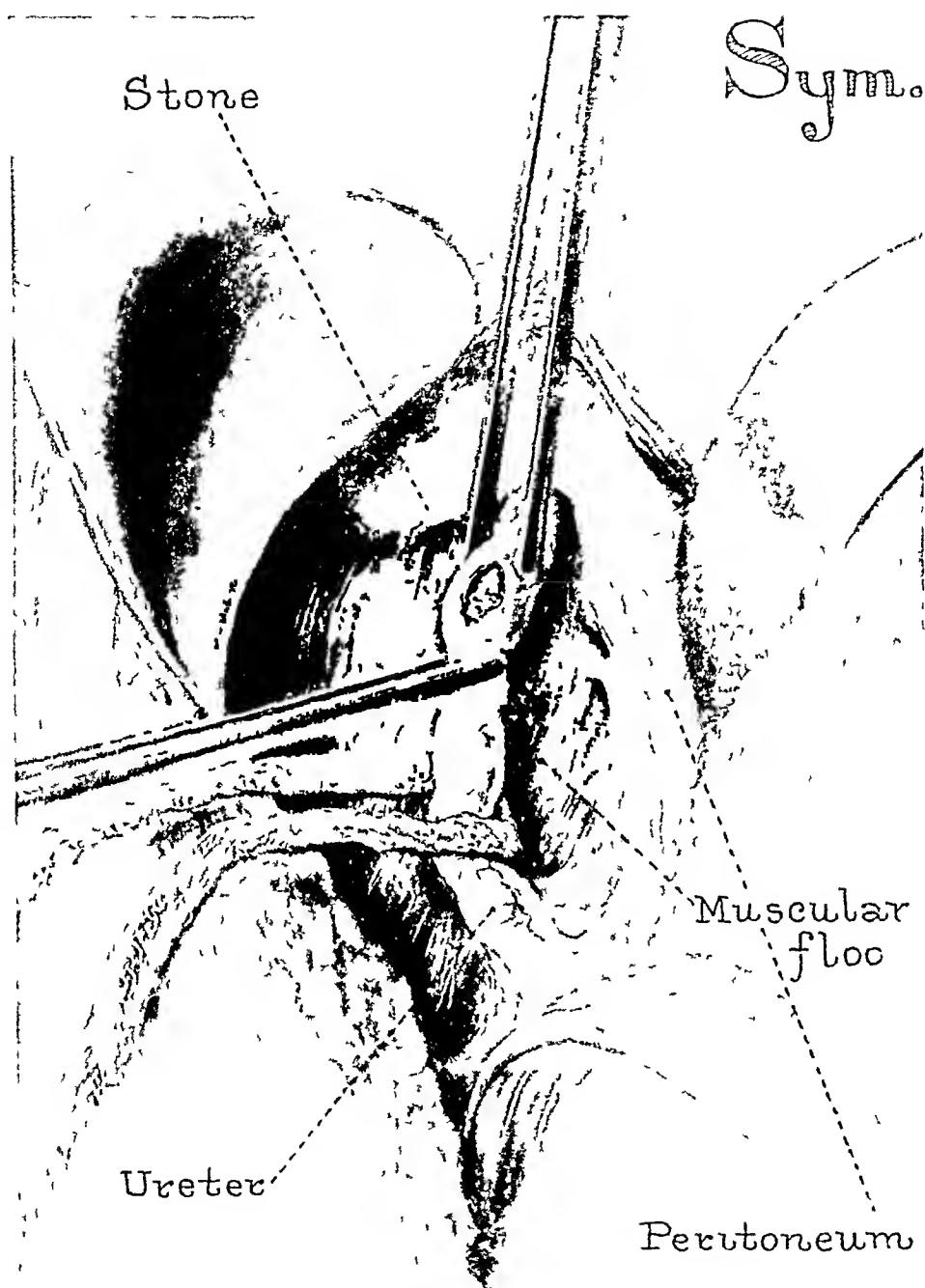


FIG 3 —Incision in ureter showing a stone

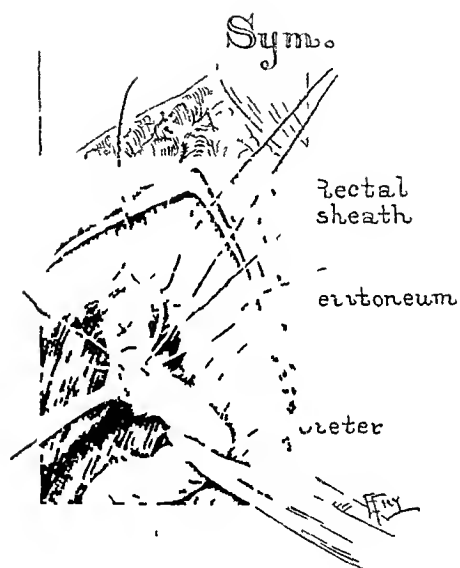


FIG 4 —Interrupted catgut sutures being placed to close incision in ureter. Sutures do not pass through mucosa.

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of the histories of these cases, and has sent out "follow-up" letters to all the 400 patients, and answers have been received from nearly 300. In approximately 90 per cent of these complete relief of former symptoms had ultimately resulted. A number of the patients mentioned the fact that they had pain in the same side and of the same character persisting for several weeks after the operation, but in most instances by the end of six months the pain had entirely disappeared. Twenty-one patients had pain severe enough at some time or other to require morphia. About 15 per cent of the patients complained of frequency, and some of them of hæmaturia lasting for several weeks after the operation, thus showing that the infection which existed at the time of operation had a tendency to clear up later. Twenty-six of the 400 patients have passed stones since the operation. Of course, it is impossible to say whether these stones came from the kidney, the ureter on the side operated on, or the opposite side.

The technic of the operation for the removal of stone from the ureter differs according to the location of the stone. If the stone is situated at the uretero-pelvic juncture, or at any place in the upper third of the ureter, the best approach is through the Mayo posterior-lateral incision, the same incision as employed to explore the kidney. If the calculus is situated in the lower two-thirds of the ureter, the straight rectus incision gives the best exposure, the exact position of the incision depending on whether or not the calculus is in the middle or lower third of the ureter. Under ordinary circumstances the operation should be performed without opening the peritoneum, since less opportunity is allowed for infection. If the peritoneum is accidentally opened it should cause no alarm, although care should be taken accurately to close it. Since the retroperitoneal space is opened by retracting the peritoneum away from the posterior muscles, the ureter will probably retract with the flap of peritoneum, so that the search for the ureter should be made on the posterior surface of the peritoneum and not on the anterior surface of the muscle. If the stone is large the ureter is usually readily located by palpation. The greatest difficulty arises in locating a small stone in the lower end of a non-dilated ureter, fortunately this is the type of case most often relieved by conservative methods. Several years ago I called attention to a technic for exposing this part of the ureter and removing such stones. The operation consists in complete exposure of the lower end of the ureter in the manner employed in operating on the bladder for neoplasm or diverticulum. The entire lower third of the ureter is brought into view. After the stone has been removed it is best, I believe, loosely to close the opening in the ureter. Since Abell reported the series of cases in which he employed this technic I have used it many times without any ill effects, and I am sure that it has made convalescence much easier and shorter. The ureter has not healed in all cases without some drainage, but it has in many, and in others the urinary drainage was very slight.

Stitching the ureter without penetrating the mucosa seems to be of distinct advantage

CONCLUSIONS

1 The study of this series of 400 patients operated on for ureteral stone and the 126 patients treated by Braasch leads us to conclude that before instituting any method of treatment for the removal of stones from the ureter, it is well to bear in mind that a large percentage of such stones pass voluntarily, in the early cases, therefore, it is best to delay treatment

2 Unless there are definite contra-indications to non-operative treatment for the removal of the stones, an attempt should be made to remove them by non-operative methods We doubt the advisability of attempting to remove stones from the middle and upper third of the ureter in this manner, but, believe that with the development of the method nearly all small stones may be removed from the lower end of the ureter without operation

3 While the operation for the removal of calculi from the ureter must be considered a major operation, it may be performed with practically no mortality and with universally good results Therefore, if there is a definite contra-indication to non-operative treatment or if progress is not being made by such treatment, the stone should be removed by open operation without hesitation

TABLE I

*Patients with Ureteral Stones Operated on at the Mayo Clinic
1901-1918 inclusive*

Total number	400
Males	248
Females	152
Location	
Right ureter	197
Left ureter	195
Bilateral involvement	5
Not stated	3

TABLE II

Age at Onset of Symptoms

	Cases
0-10 years	10
10-20 years	38
20-30 years	129
30-40 years	125
40-50 years	61
50-60 years	25
60-70 years	8
Average age	32.4 years

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TABLE III

Age of Patients on Entry to Hospital

	Cases
0-10 years	4
10-20 years	5
20-30 years	87
30-40 years	135
40-50 years	108
50-60 years	42
60-70 years	12
70-80 years	2
Average age	37.7 years

TABLE IV

Duration of Symptoms

	Cases
1 year	138
2 years	60
3 years	27
4 years	23
5 years	22
5-10 years	62
10-15 years	33
15-20 years	19
20-30 years	11
Average duration of symptoms	4.8 years
Patients entering hospital after symptoms of one year's duration	34 per cent
Patients entering hospital after symptoms of two years' duration	49 per cent

TABLE V

Pain Referred To

	Cases
Region of kidney	281
Right loin	123
Left loin	142
Both sides	16
Lower abdomen	55
Right	33
Left	22
Suprapubic region	5
Upper abdomen	63
Right	34
Left	27
Epigastric region	2
Genitals	5

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TABLE VI

Bilateral Kidney Pain

	Cases
Stone in opposite ureter also	4
Stone in opposite kidney also	5
Pyelonephritis on opposite side	1
Not determined	6

Gross Hematuria

71 cases	17.4 per cent
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Bladder Irritability

129 cases	32.1 per cent
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TABLE VII

Urimalysis

	Cases
Pus	102
Blood	39
Pus and blood	191
	<hr/>
	332 (82.6 per cent)

TABLE VIII

X-ray Findings

	Cases
Positive	295 (60 per cent)
Negative	36 (9 per cent)
Negative in 1919	11 (5.7 per cent of 193)

Cystoscopic Findings

	Cases
Definite obstruction to ureteral catheter	240 (60 per cent)
No obstruction	109 (27.2 per cent)
Stone visible at meatus	1 (1 per cent)

TABLE IX

Precious Operations

	Cases
Ureteral stone, same side	3
Ureteral stone, opposite side	1
Renal stone same side	4
Renal stone opposite side	1
Negative renal exploration, same side	3
Negative renal exploration, opposite side	1
Nephrectomy, opposite side	5
Nephrectomy, same side	2
(Nephrectomy was done five and seven years before, but stone was left in the ureteral stump)	
Bladder stone	2
Appendectomy	54
Other abdominal operations	68

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TABLE X
Negative Explorations

	Cases
Stone found in bladder	5
Definite signs of stone found at operation (stone had probably passed before operation)	3
Stone passed one month after operation with definite renal colic (Stone probably in ureter but not located)	1
Probable mistaken diagnosis	4
Mistaken diagnosis in 1919 group of 193 cases	1

TABLE XI
Location of Stones

	Cases
Ureteropelvic juncture	38
Upper third of ureter	49
Middle third of ureter	7
Iliac crest	4
Lower third of ureter	198
Ureterovesical juncture	53
Intramural	32

TABLE XII
Bilateral Involvement

	Cases
Bilateral ureteral	5
Stone in same kidney	29
Stone in opposite kidney	9
Stone in bladder	1

Mortality

- Case 216040 Operation, ureterolithotomy patient died thirteen days after operation, marked urinary extravasation was found
- Case 72640 Operation, combined ureterolithotomy and appendectomy patient died of general peritonitis

TABLE XIII
Duration of Symptoms before Nephrectomy for Ureteral Stone

	Cases
1 to 5 years	22
5 to 10 years	11
10 to 15 years	8
15 to 20 years	6
20 to 25 years	2
25 to 30 years	2
Average	8.5 years

(16 of these patients had stone in the kidney also)

TABLE XIV
Information Received in Answer to "Follow-up Letters"

Operations since leaving the clinic	12
For ureteral stone, opposite side	2
For ureteral stone, same side	0
For renal stone, opposite side	1
For renal stone same side	1

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Nephrectomy, same side (1 case complicated with nephrolithiasis)	4
Nephrectomy, opposite side	1
Negative renal exploration, same side	3
Stones passed since operation	31
Stones passed previous to operation	48 (12.3 per cent)
Multiple stones (averaging 6) passed previous to operation	9

Letters received on an average of four and one-half years after operation stated that ureteral stone had occurred on the same side in 3 cases. In 2 the first operation had been performed in the Mayo Clinic, and in one it had been performed elsewhere.

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TUBERCULOSIS OF THE APPENDIX *

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EVER since the discovery of the tubercle bacillus by Koch in 1882 and the use of improved methods of tissue sectioning and staining have made a comprehensive study of tuberculosis possible, lesions have been found in practically every tissue of the body. Yet, although tuberculosis of the appendix was described by Corbin as early as 1873, one finds very little written or said on the subject since that time. Text-books ignore it altogether or accord it only passing mention and, although in the literature we find voluminous discussions of the general subject of tuberculosis as well as of appendicitis, very few articles deal with tuberculous infections of the appendix.

In all fairness, however, it must be admitted that it is a comparatively rare condition. Scott, in 1917, was unable to find in the Index Catalogue of the Surgeon-General's library and the Index Medicus more than 44 articles on this subject, and of this number only nine were written by observers in this country.

According to Scott's collected figures, the Montreal General Hospital found tuberculosis in 16 per cent of 1259 appendices examined, Lockwood, of England, found 2 per cent involved, Allen 2 in 80 cases, or 2.5 per cent; Litz 8 in 257, or 3 per cent, Robson 5 in 300, or 1.7 per cent, Letule 2 in 300, or .7 per cent, the surgical laboratory in the University of Pennsylvania 6 in 310, or 2 per cent; Deaver 16 in 7610, or .2 per cent; Scott 1 in 179, or .57 per cent, Mayo, in 1905, reported 29 in 1888 cases, an incidence of 1.5 per cent, and in 1914, 71 in 12,003, or .5 per cent. At the University of Minnesota Hospital since January, 1916, 210 appendices have been removed and examined microscopically, and only 2, or approximately 1 per cent, were found tuberculous. From a statistical study Murphy concluded that 2 per cent of all appendectomies showed tuberculous lesions.

From these figures one is impressed by the paucity of observations on this subject when one considers that in practically every hospital and clinic of the country appendectomy is one of the most frequently performed operations. This lack of recorded observations and statistics is in many instances due to neglect of the routine sectioning and examination of all tissues by a competent pathologist. Only too often the diagnosis and prognosis is made solely from the clinical history and macroscopic appearance of the organ upon removal. Doubtless many tuberculous appendices removed in a comparatively early stage are diag-

* Read before the Minnesota Pathological Society, November 18, 1919

nosed grossly as "chronic appendicitis" and discarded, and the patient is discharged without the benefit of early instruction concerning the disease which may continue to develop until at a later date the remaining tuberculous lesions become too far advanced for either arrest or cure

Weaver also suggests that tuberculosis of the appendix in an acute condition may so closely resemble ordinary types of appendicitis and the more chronic forms, particularly the hyperplastic type, may so closely resemble malignant tumors that microscopic section is absolutely necessary for a correct diagnosis

Muller's table of age incidence of the tuberculous appendix shows the majority of the cases to have occurred in youth, their incidence roughly corresponding to the curve of occurrence of pulmonary tuberculosis. The ages affected showed wide extremes, the youngest a child two years of age and the oldest a man of forty-seven, but the largest number occurred in young adults. The disease is also more common in males than in females, the ratio being 3 : 2

TABLE I

AGE INCIDENCE OF TUBERCULOUS APPENDICITIS (MULLER)	
Years	Cases
2-9	3
10-19	18
20-29	21
30-39	16
40-49	6

Tuberculosis of the appendix may be either apparently primary or secondary to tuberculous infection in another part of the body. The former is naturally much more rare, in fact, so much so that its existence is denied by many authors. However, cases have been reported, *e g*, by Beck, where an autopsy failed to demonstrate any other focus. But one must bear in mind in such instances that there is always a possibility of a distant healed or latent focus or some microscopic lesion in a lymph-node which may have served at some time as the primary seat of the infection. In such cases as well as those of true primary infection, the theoretical possibility of which must be admitted, removal of the organ would probably result in complete cure. On the other hand, it is sometimes true that the accidental finding of tuberculosis in the appendix has been the first intimation of the presence in the body of this disease which later developed in other organs with serious consequences. Thus Mosher describes one such case of a tuberculous appendix, the condition being demonstrated by routine microscopic examination of the appendix from a case which gave no other signs of the disease at that time, but which died three years later of a pulmonary involvement.

The secondary form is frequently associated with tuberculosis of the intestines, particularly of the cæcum, or, more rarely, of the adjacent

affected fallopian tubes, a fact occasionally demonstrated by autopsies upon tuberculous patients. The question is raised by Kelly and Hurdon whether tuberculosis of the appendix antedates or follows infection of the cæcum. They point out that very frequently the more advanced lesions are found in the appendix. Whether local infection occurs by ingestion or by the hæmatogenous route, it would be natural to suppose that the bacilli might be equally disseminated along the alimentary tract with several foci appearing simultaneously, yet developing with different degrees of rapidity. Many authors, including Mayo and Brewer, report that in their experience tuberculosis of the appendix is practically always associated with the same infection in the cæcum, while, on the other hand, most observers are familiar with the fact that ileocæcal or intestinal tuberculosis is very frequently found with no involvement of the appendix, suggesting that the latter is usually secondarily affected. On the other hand, Fenwick and Dodwell found that in 17 out of 2000 autopsies on tuberculous patients the appendix was the only part of the digestive tract involved. Also Leseuer, in 144 examples of this type of appendicitis in autopsies on tuberculous patients, found 12 with no other lesion of the intestinal tract. There seems to be no good reason, therefore, to postulate any fixed rule in regard to priority of tuberculous infection of the appendix, any more than one would attempt such rules in regard to other regions of the body. Doubtless many factors, some of which are as yet only dimly recognized, contribute to the final locus of virulent tubercle bacilli. The same reasons that promote the invasion and disease of the appendix by other pathogenic bacteria may well contribute to its occasional primary or secondary infection by the bacillus of tuberculosis.

We may reasonably conclude, then, that tuberculous infection of the appendix may be produced, not only from contiguity to a neighboring lesion, but also by either the obvious hæmatogenous route from a distant focus, such as a pulmonary or bronchial lymph-node, or by the infected contents of the intestinal tract. It is particularly easy to reason that the bacilli may be swallowed, pass along the intestinal tract without causing a lesion, and finally, as do many foreign bodies and parasites, lodge in the appendix and there cause an infection. The most obvious method for tubercle bacilli to enter the intestinal tract would be the swallowing of contaminated sputum, yet it might also be brought about by infected milk, butter, cheese, or other food, and in this way cause a primary tuberculosis of the appendix. This possibility of infection becomes much more worthy of consideration when one remembers the usual dependent position of the appendix and the fecal stasis frequently occurring there.

Aside from the intestinal route, primary infection has been supposed to occur in certain cases by blood or lymph streams after direct passage through some epithelial surface. Although this is a possible theory, one finds difficulty in considering it as a probable fact, especially after study of the usual route by which the large majority of tuberculous infections

of the body probably occur. Such studies strongly suggest that almost all primary foci of tuberculosis in the body are situated either directly on exposed surfaces or in the neighboring lymph-nodes, the bacilli gaining entrance by inhalation or ingestion. Hence, ingestion of infected food would appear to be a more logical explanation of primary tuberculosis of the appendix.

Three forms of this disease are usually recognized: (1) Miliary, (2) hyperplastic, and (3) ulcerative. The so-called miliary type, however, although a true tuberculous appendicitis, is not deserving of special discussion, constituting, as it does, not a definite entity in itself, but usually being associated with a general miliary tuberculosis or tuberculous peritonitis. It really represents only a localized incident or part of a generalized infection.

The hyperplastic form is the rarest and is characterized by its very large size, a thickened wall and marked connective tissue proliferation, but little or no caseation. Occasionally the organ may be large enough to be palpated through the abdominal wall and is sometimes mistaken for a true tumor. The walls are markedly increased in thickness, measuring from 5 cm to 3 cm, Tiedenat describing one measuring 5 cm in diameter. The connective tissue overgrowth may not be entirely uniform, and by contraction may cause an irregular shape of the organ with stenosis, or, more rarely, obliteration of the lumen. This irregular shape, together with the large size, may further suggest a neoplasm. But the latter should be easily differentiated in that it is usually more circumscribed with a sharp line of demarcation from the normal tissue, while in the tuberculous process the affected tissue merges gradually into the normal with ill-defined margins. The mucosa is usually intact and normal in appearance. The submucosa may or may not present tubercles, but it is in the muscle coats that there are the most characteristic changes. Here, through and between the muscle bundles, is found an enormous increase in connective tissue, causing the large increase in the thickness of the walls. Throughout the entire tissue are scattered lymphocytes, plasma cells, and some eosinophiles. In some areas these cells congregate in varying sized masses and show in addition some endothelial cells and occasionally a giant cell, suggesting that these are the possibilities of new tubercles whose development is apparently inhibited or replaced by a marked proliferation of connective tissue. Caseation in this form is seldom seen, its absence as well as the large amount of connective tissue proliferation being due either to an attenuated strain of tubercle bacilli or (the other side of the shield) a high individual resistance.

It has also been suggested that this type of appendix, with its gross suggestion of neoplasm, may, under low power or hasty or incompetent examination, be confused with malignancy. The nests of cells may suggest embryonic tumor cells surrounded by connective tissue. This type may be either primary or secondary, but in either case is ideal for

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operation, as from its histological character it represents a slowly advancing, well controlled process, and removal should give a good prognosis

The most common form is the ulcerative lesion. It may be primary, but is usually a direct extension from lesions in the intestine, particularly the cæcum, or, more rarely, may possibly represent a hæmatogenous infection from a distant focus. The diagnosis can be made only by the microscopic section. Grossly, the organ may appear normal except for congestion of the superficial capillaries. Occasionally the walls may be slightly thickened or may show fine adhesions or tubercles over the serous surface. The mucosa is usually entirely or partially absent, due to the more or less extensive ulceration. Very often caseous material may appear as foci or forming the greater part of the floor of the ulcers.

Microscopically, the serosa appears normal or shows a few tubercles. The muscle coat is usually affected but the mucosa and submucosa show the most extensive involvement, which may be in the form of discrete tubercles or extensive ulceration or necrosis. In very advanced cases the ulceration may extend through the entire wall and cause perforation, resulting in general septic peritonitis or periappendiceal abscess formation. In the earlier stages the ulceration first appears at either the tip or base, corresponding to the points where fecal stasis is often found. This is the form one finds most often in those terminal cases where the infection becomes overwhelming and the digestive tract becomes attacked by a rapidly developing tuberculous condition just preceding a fatal termination.

Scott maintains that the tuberculous type of appendicitis may be differentiated from the suppurative form by the greater chronicity, a frequent afternoon rise in temperature, loss of weight and prostration. Even the acute attacks, when they do occur, are milder and there is an absence of leucocytosis or sustained hyperpyrexia. Other authors feel, however, that a differential diagnosis between the suppurative and tuberculous forms is always difficult and often impossible. Eisendrath quotes the statistics of Brunner which include all the published cases in which appendectomy had been performed up to that time. In these and his own 7 cases, making 58 in all, he finds 16, or over one-fourth, had symptoms identical with those of acute appendicitis. Kelly and Hurdon share the same opinion regarding the possibility of diagnosis and also note that diarrhoea and blood in the stools were frequently not noticed in the clinical data. Also the symptoms are frequently obscured by those of the co-existing tuberculous process in the intestine or cæcum.

I have three cases to report, one of which is of especial interest from the pathologist's point of view, as no signs or symptoms of tuberculosis were found in any part of the body until the routine microscopic section of the appendix revealed the lesion.

CASE I—Young man, twenty-six years of age, a Norwegian, admitted to the University Hospital on April 12, 1919, with a diagnosis of chronic appendicitis and the suggested possibility of its being of

the tuberculous type. He complained of recurring, almost daily, attacks of pain in the region of McBurney's point associated with persistent but not severe diarrhoea. His family history was negative except for the fact that his mother developed a tuberculous ankle at the age of forty-eight. With the exception of scarlet fever at twelve he had always been well until the summer of 1917, when he began to have slight attacks of pain in the right side of the abdomen. These were frequently followed by a chill and diarrhoea. They would appear about every two weeks and the pain and discomfort often lasted a week. These attacks gradually grew more severe but shorter in duration until Christmas time in 1918, when they became very severe and were accompanied by hard chills. He consulted a physician who advised him to go to a hospital, but as he felt better for a time he waited until April, 1919. During the last two years he has had about two loose stools a day, but the condition was hardly severe enough to be termed a diarrhoea.

The physical examination showed a fairly well-nourished and well-developed young man. There was a large yellow spot on the anterior surface of the right tonsil. This was not removable, as a membrane would be, or depressed like an ulcer. The submaxillary lymph-nodes were enlarged. The chest was normal except for bronchovesicular breathing in the right apex and below the right clavicle. Cog-wheel breathing was found below the left clavicle, but no râles were heard. In the abdomen there was some tenderness in the lower part, slightly more to the right than to the left. Upon sitting up more definite tenderness was found in the right lower quadrant. The urine was negative. The hæmoglobin was 100 per cent and the leucocyte count was 10,200. Red count and differential were not done. The temperature was usually normal and never above 99°.

On April 29, 1919, the appendix was removed by Dr. Donald Cameron, who noted that the cæcum at the base of the appendix appeared red and thickened. The appendix itself was also congested to a moderate degree. The patient made an uneventful recovery and was discharged from the hospital on May 5, 1919. Following his operation, however, his temperature occasionally reached 99.2°, but during the last week in the hospital it fluctuated daily from sub-normal in the morning to 99.2° to 99.4° in the afternoon.

In the routine examination of the appendix it was opened and the mucous membrane presented the frequently described "moth-eaten" appearance with ulceration of practically the entire mucosa. There was, however, no caseous material to be seen, nor did the ulceration extend beyond the submucosa. The microscopic section shows the serosa and muscle coats normal except for a very mild infiltration of lymphocytes and eosinophiles. The submucosa contains many typical tubercles, consisting of endothelioid cells, lymphocytes, and very typical giant cells. All of these tubercles are microscopic in size, some being sharply circumscribed and standing out in marked contrast to the surrounding tissue, while others appear more ill

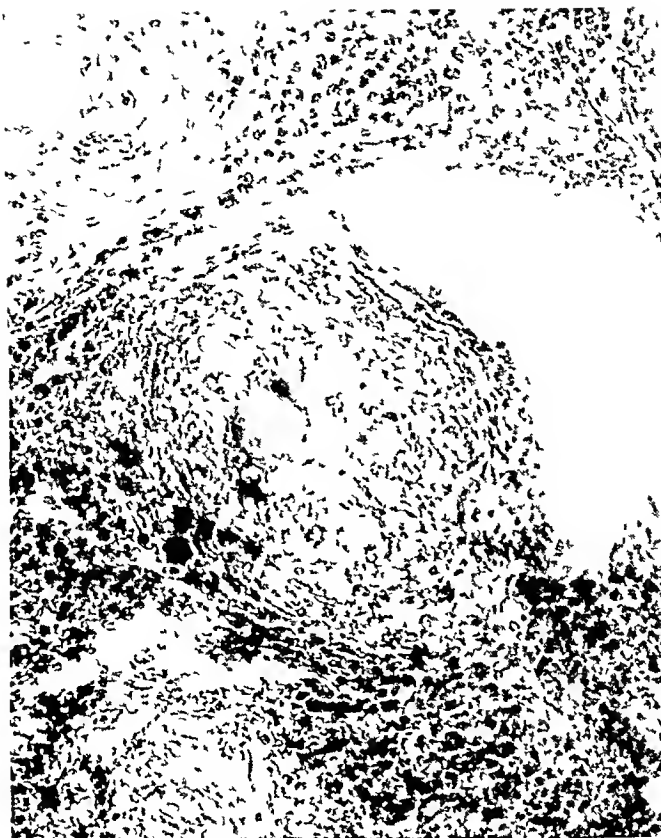


FIG 1 —(Case I) Showing a tuberculous area in the submucosa and absence of epithelium



FIG 2 —(Case III) Showing the intact mucous membrane, the marked thickening of the walls by connective tissue and the infiltration with lymphocytes Other areas showed epitheloid cells and a few giant cells

defined, merging into the tissue of the submucosa, which also contains many eosinophiles. The mucosa has entirely disappeared as a result of the ulceration (Fig. 1).

On November 15 the patient was again admitted to the University Hospital, complaining of general œdema, ascites, hydrothorax, and a decompensating heart. His incision had remained healed but his abdominal pain and discomfort had been only partially relieved by the operation. In the hospital he grew rapidly worse and died on December 2, 1919. The necropsy showed hydrothorax, ascites, general œdema, thrombosis of the right external jugular and subclavian veins, chronic adhesive pericarditis with marked dilatation of the heart (right ventricle), and tuberculosis of the intestine and the apices of both lungs. The tuberculous condition in the apices represented an acute exacerbation superimposed upon an old chronic process. There were marked adhesions to the chest wall, a fibrosis of both apices, and for a distance of about 5 cm. below were numerous miliary tubercles. In addition the right lung presented a caseous area about $\frac{1}{4}$ cm. in diameter and surrounded by a firm wall of connective tissue. The left lung showed, besides a few small caseous foci and miliary tubercles, a cavity 1 cm. in diameter with a ragged necrotic lining.

In the small intestine were a few discrete ulcers averaging 1 cm. in diameter, with puckered, thickened overhanging margins. Some of these showed evidences of partial healing, while a few were entirely healed. The cœcum was markedly thickened and the mucous membrane was replaced by extensive diffuse ulcerations. The colon also showed numerous large ulcers practically surrounding the lumen of the bowel and very similar in appearance to the small ulcers of the ileum.

This case is particularly instructive as to the potential value which might follow careful routine examinations of the appendix. In the present instance the tuberculous appendix was the first definite evidence of the probable existence of other tuberculous lesions. If these patients are warned of their condition and referred to tuberculosis consultants, precautionary measures might be adopted early enough to bring about arrest of the remaining lesions. Abnormal prolongation of the convalescence period would be the simplest of such procedures. Perhaps the majority of such patients are doomed at the time of operation, but it would be much more gratifying if one could know that no effort to effect a cure had been neglected. The autopsy shows clearly that the primary lesion had resided for some time in the apices of the lungs. An acute exacerbation of these lesions followed ulceration of the intestines and invasion of the appendix.

CASE II (From the University Hospital) —A woman, twenty-nine years of age, from the Walker State Sanatorium for Tuberculosis, was admitted on September 29, 1917, with a diagnosis of chronic appendicitis. She gave a history of having had some sort of "lung trouble"

ever since she was five years old, and of very definite active pulmonary tuberculosis with hemorrhage for the past three years. For one year before admittance she had attacks of pain which came on suddenly, were accompanied by fever, and were followed by a chill. These attacks appeared first as severe pain all over the abdomen and later localized over McBurney's point. They lasted sometimes only for a few minutes and at other times for a whole day, but in either case were followed by definite tenderness in the right lower abdomen.

Physical examination showed, besides active pulmonary tuberculosis, rigidity of right rectus and tenderness over McBurney's point. The urine was negative, the sputum contained large numbers of tubercle bacilli, the leucocyte count was 13,650, with a differential of polymorphonuclears, 80 per cent, lymphocytes, 13 per cent, large mononuclears, 2 per cent, transitionals, 2 per cent, and eosinophiles, 3 per cent. The temperature showed a daily afternoon elevation, ranging from 99.6° to 100.8°.

On October 11, 1917, under nitrous oxide anæsthesia, an appendectomy was performed by Dr J. F. Corbett. Both the cæcum and appendix were found to be markedly thickened and surrounded by a closely adherent omentum. The incision healed, the convalescence was normal, and the patient was discharged November 11, 1917. On section the appendix showed throughout the thickened wall definite tuberculous nodules and deep ulceration of the mucosa. The microscopic examination revealed absence of mucous membrane and deep ulcers extending well down into the submucosa. The wall was markedly thickened by a large amount of connective tissue and throughout were numerous endothelioid cells and giant cells with beginning necrosis.

This particular appendix earlier in the disease undoubtedly represented an example of the hyperplastic form, but at the time of removal, due to the overwhelming general tuberculous infection, showed a terminal stage where the resistance of the body was not great enough to result longer in fibrosis and both the newly formed connective tissue and the mucosa and submucosa were affected by rapidly accelerating tuberculous destruction.

CASE III — (Reported by courtesy of the patient's physician, Dr Arnold Schwyzer, and of Doctor Kaplan, pathologist to St Joseph's Hospital in St Paul.) The patient was a Jewish man, thirty-seven years of age, giving a negative family and personal history. Two years ago he had an attack of pain in the right iliac region. This was not very severe and was not accompanied by vomiting, but marked constipation was present. Olive oil relieved the condition but the soreness in that region persisted for a long time. On November 4, 1919, he had a similar but less severe attack. He was admitted to St Joseph's Hospital, a diagnosis of chronic appendicitis was made, and an appendectomy performed. The urine at that time was normal and the leucocyte count was 7200. The appendix was 8 cm

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long and, even after formol fixation, $1\frac{1}{4}$ cm in diameter. It was very hard and stiff with numerous small white tubercles scattered over the serosa. The cæcum appeared normal.

Microscopic section shows a much thickened wall. In many areas the serosa exhibits some small yet typical tubercles. The muscle coat is thickened and separated widely by a large amount of connective tissue with a few plasma cells, lymphocytes, a few endothelial cells, and occasionally a giant cell. These collections vary in size from only a few cells to areas more than covering a high power field. These foci evidently represent tubercles in various stages which are hindered in development and largely replaced by the enormous increase of connective tissue. More definite tubercles are found in the submucosa, but at no point is there necrosis. The mucosa appears normal and intact (Fig. 2).

This case is a very typical example of the hyperplastic type of this disease, while the first one illustrates just as well the ulcerative form. In both first and third cases diagnosis was made only by the routine section and examination of the appendix. In the absence of any other findings the third case may prove to be one of primary infection. However, in view of the later development of many such cases and of the frequent slow course of tuberculosis this patient should be kept under close observation for the next few years.

The terminal tuberculous appendicitis deserves at least a passing mention here, for, while not a separate process, it appears only under certain conditions. Pathologists connected with tuberculosis sanatoria consider this type of appendicitis very common. But here we find it only a part of an overwhelming terminal phase of a long existing infection in another part of the body. It is usually associated with tuberculosis of the intestine and cæcum and does not deserve special classification.

From this study one is justified in concluding (1) that tuberculous appendicitis is a definite entity which, though rare, should be considered in both diagnosis and prognosis and surely justifies routine sectioning and careful examination of all appendices removed at operation. Demonstration of the lesion may save many lives either by removal of the primary focus or by making a diagnosis so early that immediate treatment may bring about arrest or cure of the general condition.

- 2 The disease may be primary or secondary
- 3 Infection occurs directly from the intestinal contents or by the hæmatogenous or lymphatic route
- 4 It may produce either the ulcerative, hyperplastic, or miliary type
- 5 It can frequently be diagnosed only by microscopic examination
- 6 The symptoms resemble very closely those of suppurative appendicitis

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“NO SURGICAL APPENDICITIS WITHOUT ORGANIC STRICTURE” *

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THE essential contention of the first part of this argument is “That attacks of acute suppurative appendicitis are caused by the complete closure of a preformed stricture.” The observations and reasoning, which form the basis of this argument, run back over a period of ten years, the greater part of which time and effort was devoted to a checking of my belief and to the insertion of minor qualifying clauses. Unfortunately due to the pressure of other work and interests, I have no written clinical records sufficiently comprehensive to cover all the points discussed, but inasmuch as in this research I attained correlation by the simple expedient of acting as surgeon, clinician and pathologist in one, further detail would not materially improve the scientific standing of my contention. In order to minimize the personal equation, and to prove or disprove my theory scientifically, it is obvious that the problem should be tackled by surgeons, pathologists and clinicians independently, and their final conclusions compared. Suffice it to add that during these years as assistant to Dr P Y Tuppe, as incidental assistant to other surgeons and in my own personal cases, I have enjoyed liberal opportunity of studying the problem. In over 250 acute appendicitis cases and in well over twice as many interval cases, I have been able, satisfactorily to myself, to check the clinical history against the pathological finding, and *vice versa*, and in a large percentage of these cases to learn of or follow the course in later years.

With these preliminaries out of the way, let us proceed to our observations on and considerations of the living gross pathology. Any surgeon accustomed to seeing acute suppurative appendices within the first twenty-four hours from the beginning of the attack, must have noted that whereas the whole distal end was greatly distended and engorged, the cecal half-inch more or less very commonly appeared practically normal. There is, to be sure, usually a slight oedema and injection of the relatively normal part of the appendix, and in a small percentage of cases the inflammation of the appendix runs flush up to and even out onto the cecal wall. In appendices removed at this stage, with a normal appearing section distal to the clamp, it has been my experience in the great majority of cases that, although there is obviously fluid under tension in the appendix, none escapes from the severed end, nor can it be made to do so even by increasing, *via* manipulation, the intra-appendiceal pressure markedly. Now if an eight-inch olive-pointed sound, or an ordinary match-head, which fulfils every requirement, be passed through the

* Read in modified form before the St Louis Medical Society, June 3, 1919

normal part of the appendix, it will meet firm resistance at the line of demarcation noted on external examination. This of course diagnoses the stricture, while the fact that the stricture was pervious until just before the attack can be verified grossly by the finding of decomposed fecal material in the shut-off portion of the appendix. The firmness of the white fibrous tissue in the stricture determines that it existed before the onset of the acute attack, while on complete sectioning the marked differences in the gross appearance of the mucosa proximal and distal to the stricture demonstrate beyond reasonable doubt, in my opinion, that the stricture is the controlling factor. In a few cases the stricture allowed pus to leak out from the appendix at this early stage, which would obviously be a fortunate turn of the fates for any patient not in a place or condition for a surgical operation. But while noting the rarity of leakage from the appendix into the cæcum during early stages, let me state my judgment that it is a common occurrence in later stages, which leakage by acting as an alternate way out for the pus avoids many a perforation.

And now passing on to the consideration of appendices seen in later stages, let me recall to mind some of the gross physical characteristics of the still all too common gangrene. A typical early stage of gangrene might be pictured as a distended appendix, perchance pretty evenly of a dark purple or, if fecal concretions happen to be present, more advanced grayish spots in association with these concretions. But the point I wish to call attention to is that in the great majority of cases this beginning gangrene stops abruptly at variable distances out from the cæcum. In cases seen still later, when the gangrenous process has reduced the appendix to a skeleton of blackened submucosa, an intensely red stub may be noted in most cases protruding from the cæcum. To be sure, as in other stages, the gangrene in a small percentage of cases involves all the appendix flush up to the cæcum. Finally for a variable distance away from the appendix the mesentery is involved in the gangrenous process, ordinarily in direct proportion to the appendiceal condition.

Now as to the cause of this gangrene, there has been a widespread tendency to attribute it primarily to interference with and eventually complete blockade of the blood supply of the appendix. Admittedly in all gangrenes there is an interference with and eventually complete blockade of the blood supply, and yet in all such cases we must go one step further and answer the question as to whether the blockade of the blood supply was primary, the infection being a secondary sequel, or whether the infection was the primary element, the clotting of the blood in the vessels being secondary. To cite typical examples of these alternates,—in senile gangrene with arteriosclerosis plus thrombosis the interference with the arterial supply is obviously the essential element, whatever infection occurs being distinctly secondary, whereas in diabetic gangrene with normal vessels the infection makes fearful progress on account of lowered resistance, the clotting of blood in such cases being distinctly a secondary process. Or to illustrate my point by the war experiences, while in many cases the interference with the arterial supply was

the sole factor in the production of gangrene and in others obviously the controlling factor, still in many cases infection played an equal or larger rôle, and in a big proportion the relative virulence of the infection was practically the only factor in the development of gangrene

And now as a means of getting directly to the heart of the problem, let me state my conclusion at the outset, which is that in a case of gangrenous appendicitis the infection is the primary and controlling element, whatever clotting of blood there is being secondary. To marshal the reasons on which I base this conclusion, in the first place the probability of an embolus lodging exclusively in the appendiceal artery is so infinitesimally small that even the supporters of the hæmatogenous origin of appendicitis admit it is practically not worth considering. On the basis of the common concurrence of infection elsewhere in the body and appendicitis they argue a selective affinity of certain blood-transported bacteria for the appendix, and further have presented some animal experimental evidence claimed to sustain their view.¹ The routine answer to that contention is that such cases of infection elsewhere and appendicitis are coincidences, with no or at least a very indirect cause and effect relationship. While the supporters of the hæmatogenous origin of appendicitis unquestionably feel that they have gathered sufficient evidence to be entitled to a respectful hearing, it would be relying on ignorance of recorded observations to make claims beyond that point. But to bring forward my specific points against the hæmatogenous theory, if my preceding observations are correct, it is obvious that the proponents should amend their claim to read "a selective affinity for the distal portions of the appendix." Further let me state definitely that I have found the same relationship between stricture and appendicitis, absolutely irrespective as to whether the patient was suffering from an acute or chronic infection elsewhere, or not. And granting the presence of a firm stricture, which locks up bacteria-laden fæces, surely no one would claim that any other factor was necessary to account for all the phenomena of acute suppurating appendices.

As regards judging from the gross appearance of a series of acute appendices as to whether the infection is primarily in the blood supply, I tried to weigh this problem as impartially as possible, but naturally would have some residual prejudice. Consequently I lay no stress on my judgment that the evidence seemed to me to point strongly to the origin of the infection within the lumen. But to show that my contention that the infection in appendicitis progresses from the lumen outwardly is in agreement with the general opinion of pathologists, let me offer this quotation from MacCallum in *Text-book of Pathology*, 1916, page 226: "Appendicitis is an acute infectious disease produced by the invasion of bacteria from the lumen into the mucosa and other walls. The hæmatogenous infection of the appendix walls by bacteria transported from infected tonsils, which Kretz regards as

¹E. C. Rosenow. Etiology and Experimental Production of Appendicitis, Ulcer of the Stomach, and Cholecystitis. *Tenn. State Med. Assn.*, vol. VIII, No. 5, pp. 205-209, also *Journal Infectious Diseases*, vol. XVIII, No. 4.

a common origin of appendicitis, has not been clearly shown to take place. If it does so it must be considered an exceptional occurrence, and does not explain the majority of cases in which infection from the lumen can be conclusively demonstrated."

The pathology of the true chronic appendix is, in my judgment absolutely the same as outlined above for the acute appendix, except for the absence of acute infection. The stricture, which is pervious during interval stages, may be located at any point from near the distal end down to the very connection with the cæcum. If the stricture is located at the cæcum or relatively close up, it would obviously not be demonstrable after a routine appendectomy, which would account for a certain number of true chronic appendices apparently without stricture. But in these cases the stricture can be readily made out by palpation and can even be demonstrated to those about the operating table, provided they know the appearance of the normal for a contrast. If there have been only a few and minor previous attacks the submucosa may not have changed materially from the normal, but when the process has gone on longer the whole submucosa distal to the stricture becomes much thickened. In regard to the relation of appendicitis and adhesions, the evidence seems to be overwhelmingly in favor of the appendicitis as the cause of the adhesions, rather than the reverse, as is so commonly argued. Genuine kinks of the appendix are, in my experience, usually associated with stricture at the site, while all pathology of spurious kinks vanishes when the organ is removed from the body. I have seen two cases in which the stricture at the time of removal was only relative, that is the fecal concretions were of such a size that it couldn't possibly pass through the intervening normally patent submucosa into the cæcum. Finally in patients from whom the appendix was removed purely incidentally to some other abdominal operation, I have found quite frequently strictures within the last quarter or half inch of the tip. Fact is this finding has been present with sufficient frequency to make me sympathize with those who look on this common obliterating process not as a true involution but as the end-result of an inflammation. And further that the occasionally found mucocèles, distal to a stricture, are simply a transitory stage in the progress towards complete obliteration.

And now to discuss briefly some related points purposely postponed until this stage of the argument. Acute catarrhal appendicitis without stricture such as is to be found, for example, in typhoid fever² and presumably any other acute enteritis, does not give the symptoms of surgical appendicitis nor call for operative intervention. The same logic seems to me fully as justified in regard to the question of chronic catarrhal appendicitis without stricture, that is rational control of the whole process and not simply appendectomy. While tuberculosis and similar infections may theoretically attack the appendix exclusively, practically they usually attack the large intestine concurrently and besides they do not give *per se* the symptoms of surgical appendi-

² McCrae: Osler's Modern Medicine 1907, vol. II, p. 98, par. 3

citis As to the cause of the formation of strictures in the appendix, beyond the unsupported surmise that a simple ulcer precedes the development of the stricture, I have absolutely nothing to offer. Inasmuch as during the finding of hundreds of strictures of the appendix I have never seen this theoretical pre-stricture ulcer, I feel justified in drawing the conclusion that the ulcer only rarely, if ever, gives symptoms leading to surgical intervention.

During these years of testing my conception of the pathology against the clinical course of the disease I have made it an invariable rule to separate those cases which definitely had a stricture from those cases which definitely did not have one, leaving out of consideration a few cases of doubtful classification. The differences between these two groups were so marked as regards both the past and the future that any one who draws this pathological line through a series of cases must be at once impressed by them. Thus, whereas the strictured cases, after throwing out of account as genuine first attacks such as gave absolutely no previous story of abdominal pain, almost all gave a definite history of characteristic sharp attacks, the non-strictured cases ordinarily told a much less characteristic story and very commonly failed to give any history at all of sharp pain. As regards future course the difference was even more marked, for practically all the failures to relieve belonged to the non-stricture group, which statement, however, does not deny at all that many of the non-strictured cases either were relieved or felt they were relieved, which from a purely practical point of view approaches the same thing. And finally the whole clinical course of acute suppurative appendicitis is so readily explicable on the basis of my conception of the pathology, to wit—The closure of the stricture ushers in the attack—the ensuing colicky pain due to the commonly futile attempts on the part of the appendix to empty out its contents—then the involvement of the appendiceal walls causing low fever with leucocytosis, the cessation of appendiceal peristalsis, and in its place localized tenderness to deep pressure.

The foregoing completes the brief of my direct evidence. And here many readers will undoubtedly have the mental reaction "While the preceding argument does not sound unreasonable, still what explanation have you to offer that such a proposition was overlooked in so intensely cultivated a field as appendicitis?" As far as my alleged facts are concerned they should be able to stand on their merits, but the question strikes me as pertinent and deserving an answer, particularly inasmuch as individual opinion and judgment has unavoidably entered to a minor degree into the argument. My explanation is that it's a borderline proposition—everybody's—and therefore proverbially nobody's business! The only way it could be worked out would be for surgeons, pathologists and internists really to put their heads together on the problem, or for an individual with a reasonable grasp of all three subjects to catch the significance of the various details and fit them into their proper place in the composite picture. Most all pathologists have stressed the important cause and effect relationship between strictures and surgical appendicitis, while in this argument I have simply gone one step

further by adding the negative, without stricture no surgical appendicitis. As far as catching this negative point is concerned, the straight specialist in pathology would obviously be at a great disadvantage, inasmuch as he or she isn't really in close touch with the living pathology and complete clinical history, while the specimens delivered to him quite commonly do not include the stricture at all.

Finally, any one in touch with the literature and general sentiment in regard to appendicitis during the past ten years must have noted the gradual growth of skepticism among progressive men towards what I consider near-pathology and near-symptoms. In support of this statement I could quote internists of standing from the literature and personal communications more or less indefinitely, but as this argument is presented primarily to surgeons I will close my case with a recent protest from so representative a surgeon as Bevan (*Surgical Clinics of Chicago*, April, 1919, p. 309, par. 2). "There is one phase of the question that I should like to discuss with you, and that is the so-called cases of chronic appendicitis, those cases that have never had an acute attack, but which are supposed to have a chronic infection in the appendix giving rise to slight distress in that region. I want to state my opinion on this subject very strongly, and it is that most of these cases are mistakes in diagnosis, and not cases of appendicitis at all, and personally I do not recognize such a condition as chronic appendicitis which has never given rise to any acute symptoms."

CONCLUSIONS

- 1 Attacks of acute suppurative appendicitis are brought on by the complete closure of a preformed stricture
- 2 The inflammation, eventually gangrene, is due to the action of the bacteria normally present in the locked-up feces
- 3 The true chronic appendix also has a stricture, which, however, is patent during intervals between attacks

THE ADVANTAGES OF THE MIKULICZ TWO-STAGE OPERATION OF PARTIAL COLECTOMY

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THE early intestinal resections were largely done by the help of temporary artificial anastomosis. As surgery progressed the elements which control sepsis were better understood and the wonderful healing power of the intestine was better appreciated. Immediate suture was successfully practiced and the one-stage operation became the procedure of choice either with immediate closure of the wound or with provision for drainage. An immediate healing with prompt restoration of function is surely more desirable than a delayed union and the discomforts of even a temporary intestinal stoma.

There are, however, certain advantages inherent in the two-stage operation. In 1902 Mikulicz formulated these advantages, described the operation which ordinarily bears his name and recorded cases which showed remarkable reduction in mortality rate. He had then used the procedure for more than five years. He thoroughly mobilized the portion of intestine which was to be removed and delivered it through the abdominal wound after stitching together the serous surfaces of its afferent and efferent portions. He then closed the incision to the emergence of the intestine, stitched the skin edges to the intestinal wall and applied protective ointment and a surgical dressing over the incision. This was all accomplished without opening the intestine. He either left the extruded portion in the dressing to be removed at a later time or excised it at once and provided for drainage at a safe distance from the wound. A temporary stoma was left. The "spur" was clamped through at a later time and then the intestinal ends brought together by suture.

Many surgeons have adopted this operation on account of its diminished mortality rate. However, the records published in surgical literature indicate that it is only used in a moderate portion of those cases for whom it might be considered suitable. For instance, in the last ten volumes of the ANNALS OF SURGERY we find records of 26 operations for obstructive disease of the colon. They were distributed as follows:

End-to-end suture	9
Lateral anastomosis	7
Short circuiting	6
Mikulicz operation	2
Exploratory operation	1
Colostomy	1

If we study the 32 cases of cancer of the splenic flexure which Hartwell collected from the literature from 1906 to 1918, we find the following records

Mikulicz, or similar procedure	9
Lateral anastomosis	7
End-to-end suture	5
Short circuiting	3
Colostomy	6
Colostomy with extirpation of tumor	1
End-to-side anastomosis	1
Inoperable cases	6

These reports show great diversity of method and suggest the desirability of further consideration of certain elements which bear on the relative advantages of one-stage operations and two-stage operations when portions of the intestine are to be removed. These elements are

- 1 Septic intestinal content
- 2 Extent of peritoneal intestinal covering
- 3 Condition of patient
- 4 Peritoneal sepsis
- 5 Conservation of nutrition
- 6 Skin irritation from leakage of intestinal content
- 7 Reflex effect of fastening different parts of the intestine to the abdominal wall

These elements differ in different parts of the intestine and in different patients

Small Intestine —The small intestine presents elements which favor one-stage operation in almost all instances. The intestinal content is fluid and, ordinarily, is rapidly moving and has little septic power. The peritoneal covering is close to the muscular wall of the intestine excepting at the small mesenteric border and hence gives abundant opportunity for strong opposition. Cancer is rare here and hence we do not often have to deal with debilitated patients. Furthermore, the disadvantages of the two-stage operation apply to the small intestine with especial force. Inanition results from too much intestinal leakage. Skin irritation, or even skin digestion, follow the leakage of fluid which still has digestive power. The reflex disturbance from fixation is greater from the small than from the large intestine. Hence the two-stage operation is only applicable to the small intestine in especial emergencies. For instance, strangulated hernia with gangrene of the intestine and spreading infection of the adjacent tissues.

Ileo-cæcal Region —At the ileo-cæcal region the conditions still favor the one-stage operation. The intestinal content is still fluid, it has only moderate infective power and ordinarily moves with fair rapidity. The peritoneum of the ileum is close to the muscular coat excepting at the mesenteric border, and the peritoneum of the large intestine gives abundant opportunity for serous apposition of either lateral or end-to-side anastomosis. Provision for possible leakage is easily obtained.

Colon, Hepatic Flexure to Terminal Sigmoid—The colon from the hepatic flexure to the terminal sigmoid is the region for which the two-stage operation is especially considered. This region furnishes nearly 70 per cent of the intestinal cancers above the rectum¹. Here we have an intestinal content which is semi-solid, or possibly solid. It holds vast numbers of bacteria. Mayo states that it has been shown that one-quarter to one-third of the stool bulk is due to bacterial growth. Partial obstruction exists in a large proportion of the cancers of this region which come to operation, hence this septic intestinal content cannot be satisfactorily eliminated and forms a serious menace to satisfactory healing.

The peritoneal covering is frequently defective. This defect in the upper part of the descending colon is due to the anatomical arrangement which usually leaves the posterior portion of the gut uncovered by peritoneum. However, the deposit of fat between the peritoneum and the muscular coats of the intestine is sometimes the main barrier to satisfactory serous apposition. In the sigmoid and descending colon one frequently notices at operation that the strip of peritoneum which lies close to the muscular wall is only one-half to three-quarters of an inch in width and that there is a thick deposit of fat elsewhere. This fat deposit is shown in the appendices epiploici, but in many instances is massive and really envelops a large part of the intestinal wall. Of course, in those patients who are debilitated by cancer it has usually been absorbed, but some patients come to operation in whom it is still present, hence operation must be planned with the understanding that fat deposit may hamper serous apposition of the divided intestinal ends.

The condition of the patient may be a strong barrier to a successful one-stage operation. The majority of these patients suffer from cancer and have suffered for a long time before they come to operation. They have little resisting power and hence operative procedure must be planned so that they will not have more than they can endure.

Peritoneal sepsis does not often come in these patients, but a perforation is occasionally found which leads to considerable peritoneal sepsis and hence forbids a type of anastomosis which otherwise might be made.

The interference with nutrition, the skin irritation and the reflex effect of fastening the intestine to the abdominal wall are all minimized in the two-stage operation on the colon as compared with the small intestine.

We therefore have many reasons why a two-stage operation should be used in a large number of partial colectomies.

Statistics Comparing Results of Different Types of Operation—If we study records of operations we find further reason for using the two-stage procedure. Mikulicz² emphasized the advantages of this procedure and gave detailed reports of its efficiency in the Breslau clinic. The mortality of intestinal resections by the one-stage operation was 42.9 per cent, whereas by his two-stage operation he did sixteen cases

with only two deaths—a mortality of $12\frac{1}{2}$ per cent—and these two deaths were not, primarily, due to the operation

The procedure has been much used in the intervening years Oppel³ quotes Finkelstein as showing in the collective study of results that the mortality of the one-stage operation had been 29 per cent, and that of the Mikulicz two-stage operation had been 16 per cent

Mayo⁴ states that the adoption of the Mikulicz-Bruns method has probably done more to extend operability and reduce mortality in resections in the second half of the colon than any other factor By adopting this method in a large proportion of the operations he resected the left half of the colon, including the splenic flexure but not including the rectum, 184 times, with a mortality rate of 17 per cent

Hartwell's⁵ recent study of cancer of the splenic flexure is very important, although discouraging After a careful study of the literature, he estimates that the probable operative mortality of all cases, up to the present time, is over 60 per cent But the results from operation in many stages is much better than that in one stage He states that his "collected cases show a mortality approximately three times greater in the one-stage than in the many-stage procedure Careful study indicates that the failures in the one-stage operation would have been avoided by the other mode of attack These failures arose almost entirely from leakage somewhere along a suture line, with a resultant peritonitis or improperly drained abscess"

The late James P Tuttle once told me that he had successfully done five successive partial colectomies by the Mikulicz method, whereas his previous mortality rate, in similar conditions by other methods, had been 33 per cent

We thus see that there are abundant records to show that the two-stage or many-stage operation has a much lower mortality rate than the one-stage operation

Record of Personal Operations—The author's early cases were mostly admitted to the hospital on account of symptoms of obstruction It was not always possible to secure satisfactory cleansing of the intestine Anastomosis with immediate return of the intestine to the abdomen was sometimes successful and satisfactory, but, even in those patients in whom a preliminary colostomy was done, there were enough failures to lead to a search for a better method The following cases illustrate the use of the Mikulicz method The mortality rate, one in eight, is much better than that obtained by immediate suture

CASE I—*Adenocarcinoma of sigmoid* A L, aged fifty-one years Roosevelt Hospital, No A15023 Operation March 29, 1919 Fourteen months previously he had had an abscess beside the descending colon which had healed but had again been opened in February, 1919 At operation, an adenocarcinoma was found in the upper part of the sigmoid This was mobilized and the diseased

part of the intestine was delivered through the abdominal incision. The procedure was much hampered by the presence of the discharging sinus. A loop of small intestine was adherent to the sigmoid and was necessarily exposed to the infection from this sinus. It was, however, returned to the abdominal cavity. The diseased portion of the colon was delivered through the abdominal wound. Wound closed to the point of emergence after the afferent and efferent legs of intestine had been united. The wound was protected by ointment and gauze, protruding portions of intestine double ligated at a distance from the skin edges, tumor excised outside of primary dressing. Exposed mucous membrane cauterized. Ligatures cut forty-eight hours later. The patient died of general peritonitis six days later. His death was apparently due to infection from the sinus and attached coil of small intestine which had come in contact with it.

CASE II—*Adenocarcinoma of descending colon* Mrs F I, aged sixty-five years. One-year intermittent pain in left side. Worse of late. Had lost 25 pounds in weight. Palpable mass in left side of abdomen. Operation June 29, 1918. Intermuscular incision above and in front of anterior superior spine of ilium. Descending colon mobilized and delivered through the wound. Annular growth just above the sigmoid. Serous surfaces of afferent and efferent portions united with catgut. Wound closed to the emergence of intestine. Intestine stitched to skin, also further secured by tape. Ointment and surgical dressing applied over the wound. Protruding intestine double ligated. Diseased portion ablated external to the ligatures. Mucous membrane cauterized and secondary dressing applied. Ligatures removed on second day. Spur clamped in two weeks.

Second operation July 30, 1918. The operation was done in an adjoining city and patient had not been seen by the author since the primary operation. A clamp was applied to that portion of the spur which still remained. The intestinal edges stitched together to the emergence of this clamp and the union was reinforced by stitches through the fascia and skin. The wound closed promptly excepting for a very small sinus. The sinus soon closed completely. She made an excellent recovery and is now in good health with no evidence of recurrence.

CASE III—*Adenocarcinoma of transverse colon* J D, aged fifty-three years. Roosevelt Hospital, No A14317. Eleven months' history of cramp-like pains intermitting and recurring. Loss of weight, 15 pounds. April 15, 1918, partial colectomy through an incision in upper right rectus. Gastro-colic omentum separated from greater curvature of stomach. Growth mobilized and delivered, serous surfaces of afferent and efferent legs united with catgut. Wound closed to emergence of intestine. Skin stitched to intestinal wall. Dressing applied to abdominal wound. Clamps applied to intestine leaving about one and one-half inches between the clamps and abdominal wound. Clamps removed in thirty-six hours.

There was satisfactory healing, but the patient was much debilitated and did not gain strength rapidly. Clamp applied to spur May 3. Attempt to close stoma by loosening the attachments and applying stitches in layers May 18. This was only partially successful and was repeated June 24. After this there was slight leakage, but the wound was entirely closed on September 3, and the patient has remained in excellent health ever since. Has done routine duty as policeman, and is now in excellent health.

CASE IV—*Adenocarcinoma of descending colon* Mrs T, aged fifty-two years. Roosevelt Hospital, No A14356. Abdominal pain colic, vomiting recurring in intermittent attacks six weeks or more. Operation May 11, 1918. Long incision through the left rectus muscle. An annular constricting adenocarcinoma was found in the descending colon just below the level of the costal border. This and the adjoining portion of the intestine were mobilized and delivered through a second, left intermuscular incision. Serous surfaces of afferent and efferent legs united with catgut. Wound closed to the emergence of intestine. Skin edges stitched to intestinal walls. Intestine further held by glass rod. Wound dressed with ointment and gauze. Intestine double ligated outside the layers of gauze. Tumor and adjoining intestine ablated. Mucous membrane cauterized. Further dressing applied. Two days later the constricting ligature was removed from the afferent intestine, satisfactory intestinal stoma established. Spur clamped in two weeks. Colostomy opening closed in layers July 22. Patient left hospital September 12. All steps in her procedure were slow on account of her weakened condition. Wound closed satisfactorily, and she remains in excellent health at the present time.

CASE V—*Colloid carcinoma of descending colon* Mrs E W, aged thirty-two years. Roosevelt Hospital, No A8521. Four months' history of cramp-like pains in abdomen and back. Operation May 9, 1917. Growth and adjoining portion of descending colon mobilized and brought through left abdominal wound. Serous surfaces of afferent and efferent legs joined with catgut. Wound closed to emergence of intestine. Skin edge stitched to intestine. Intestine further stabilized by glass rod. Two ligatures applied outside the dressing. Intestine excised outside the ligatures. Mucous membrane cauterized. Ligatures removed two and three days after operation. Suitable stoma established. Spur clamped two weeks after operation. Ends of intestine united June 12. Patient left hospital, with wound healed, June 30.

CASE VI—*Adenocarcinoma of sigmoid* Mrs A G, aged thirty-nine years. Roosevelt Hospital, No A6340. Operation June 19, 1915, for a recurring cancer of the sigmoid. Intestine mobilized. Afferent and efferent legs united with catgut. Mobilized portion delivered through the left intermuscular incision. Skin edges stitched to intestinal wall. Dressing applied. Intestine double ligated outside the primary dressing. Ligatures about afferent end of intes-

tine removed in forty-eight hours Stoma established Spur clamped in about two weeks Ends of intestine sewed together July 29 Patient left hospital, with stoma closed, August 15

CASE VII—*Extensive tuberculosis of caput coli and lower ileum* B S, aged thirty-five years, General Memorial Hospital, December 12, 1912 One-stage operation not done on account of infection which was present Mikulicz procedure with immediate removal of diseased intestine Stormy convalescence owing, in large measure, to illness not connected with the intestine Spur cut down, stoma closed Patient left hospital after two months and made excellent recovery after three additional months of treatment, and remains well at the present time

CASE VIII—*Diverticulitis Perforation Abscess formation* C A, aged sixty-four years, Roosevelt Hospital, No B3281 Three months intermittent, left abdominal pain and constipation Large palpable mass in left side of abdomen Operation September 13, 1912 Large mass, composed of perforated descending colon and encapsulating omental and pericolonic fat, mobilized and delivered through left lateral incision Serous surfaces of afferent and efferent intestine stitched together with catgut Abdominal incision closed to the emergence of the intestine Skin edges stitched to intestine and retaining tape placed between the intestinal loops Dressing applied Ligation of protruding intestinal loops outside of primary dressing Ablation of inflammatory mass Exposed mucous membrane cauterized External dressing applied Ligature removed after seventy-two hours and stoma established Part of spur clamped on fifth day to seventh day Remaining spur clamped at a later time An effort was made to close the stoma October 13 This was successful excepting for a small fistula which was closed on November 3 Patient left hospital on December 14 with wound satisfactorily closed

This series of cases is too small for extensive deductions, but it is sufficient to indicate that the Mikulicz procedure is far safer in the colon than the one-stage procedure The low mortality rate—12½ per cent—corresponds to that of other operators The one fatal case was due to a rare complication, we do not often find an open sinus and a loop of small intestine adherent to the infected area

Of course, delay in healing, unpleasant convalescence and probability of hernia constitute the main barriers to this procedure In this series the delay has often been longer than was absolutely necessary While a debilitated patient is gaining strength steadily, but slowly, one hesitates about even moderate surgery when a little longer waiting is sure to make the closing of the stoma easier Absence from the city also occasioned delay in some instances Mayo begins the clamping of the spur ten or twelve days after the primary operation and expects its division to be complete in six more days "A few days later the resulting colostomy can be closed by a simple extra-peritoneal operation" In two of my cases the healing was complete in respectively six and one-

half and nine and one-half weeks. In five cases small sinuses remained for three to five months before final healing occurred. These were not enough to occasion serious inconvenience and the patients preferred delay to further stitching. When we appreciate the greater safety, we may be sure that most patients would be willing to purchase this safety by a delay in convalescence and the associated discomforts.

Final Results—Proper mobilization of the desired portion of the intestines is the first element in obtaining good final results. If the adjacent tissues or lymph-nodes are involved, they, too, are to be removed when possible. This is done without regard to the method of excision. Considering the increased percentage of recoveries, the final results of the two-stage operation are much better than those of the one-stage operation.

Applicability of the One-stage Procedure—Without doubt, there are patients in whom the one-stage operation can be successfully done. Such patients should be fairly strong and their colons should be nearly empty and should be comparatively free from fat. Before deciding to use this method, one may well remember the brilliant results which Mayo and Mikulicz have obtained by the two-stage procedure, and Hartwell's studies which show that the one-stage procedure has had a mortality rate three times greater than the many-stage method.

It is not my purpose to advocate the two-stage procedure for all cases, but rather to call attention to its advantages and to urge its use in the average case as it now comes to us in the hospital, reserving immediate suture in the colon for those patients who are especially fitted for it.

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ANATOMICAL CONSIDERATIONS IN THE RECTAL PROLAPSE OF INFANTS

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IN a former paper contributed to this journal I have drawn attention to certain functional characteristics of the perirectal tissue. In this I confirmed statements already made by my former colleagues, to whose work references are there given.⁷ In the dissection of the pelvis of the full-term foetus and the infant, certain additional facts have come to light which possess their own significance in the consideration of cases of rectal prolapse.

The investigation of cases of so-called rectal prolapse resolves the condition into three types, which are described by clinicians as commencing in varying situations:

- 1 At the anal margin
- 2 At a certain distance above the anal margin and protruding
- 3 At a higher level (pelvic colon) and not protruding.⁸

The second and third of these types clearly belong to the class of intussusceptions, differing from the ordinary clinical condition known as intussusception only in that the entering portion of bowel commences its progress through the intussusciens low down in the distal colon, it may be in the rectum itself. The anatomical features of the distal colon show there to be two situations favorable for the development of an intussusception. These are the pelvirectal junction and the subdivision of the rectum at the great valve of Houston. For at each of these positions there is a more or less marked infolding of the bowel wall, and both correspond to the junction of a higher comparatively mobile portion of the bowel with a lower, more fixed portion.

The nature of the fixation differs in the two instances. At the junction of pelvic colon with rectum there is the sudden loss of the mesocolon. The change from the presence to the absence of the mesentery cannot, however, be a very potent factor in inducing intussusception. Indeed, from the looseness of the subperitoneal tissue in this area one might well doubt whether it would have any importance at all.

In the case of the lower situation, namely, the location of the great valve of Houston, the problem is a different one, and one for which a more plausible solution is indicated. The muscular diaphragm of the pelvis, constituted in large part by the two levatores ani, is generally held to be the main support of the rectum. As I showed in the previous article, this is only partially true. Lack of tone in the pelvic diaphragm

will certainly allow the rectum to become prolapsed to a limited extent. But the muscles indicated are not the only or indeed the main support of the rectum. The organ is upheld by the attachment to it of the perineural and perivascular tissue known as the rectal stalks¹ or *les ailerons*⁶. These form the lateral portions of the fascia propria,⁴ part of which does not become thinner as it passes upward, as Waldeyer suggested,¹⁰ but is attached to the sacrum at the level of the third sacral vertebra or thereabouts⁷. The rectal stalks comprise the tissue surrounding the middle hæmorrhoidal vessels and visceral pelvic nerves, of which branches from the third and fourth sacral trunks pass to the rectum. They are attached to the lateral walls of the perineal chamber^{8, 11} or ampulla of the organ. Hence this portion of the rectum is more fixed than the pelvic chamber to which no portion of the stalks is attached.

It is not, however, intended in this paper that attention be directed to intussusceptive forms of rectal prolapse, but rather to that type which commences at the actual anal margin, and which is thus a true prolapse or procidentia of the rectum.

Inasmuch as the manner of support of the rectum is concerned in cases of rectal prolapse, and in view of the occurrence of this condition in infants and young children, it may be of service to put on record the results of investigation on the infant pelvis.

On consultation of the literature for the accepted or suggested etiology of prolapse, some of the causes given recommend themselves with greater force than others to one's judgment. Overloaded rectum and straining at stool naturally have their place in the etiology of the condition, in association with other causative factors, such as lack of muscular tone in the pelvic diaphragm and diminution of the fat in the ischiorectal fossæ occurring in rickets and wasting diseases. As is well known, the sacrum of the infant is straighter than that of the adult, and consequently the rectum is more vertically placed. It is conceivable that all these factors, acting in harmony, will tend to produce rectal prolapse in young children. On the other hand, prolapse of a very persistent and troublesome nature does occasionally occur in children who, apart from the condition indicated, show no departure from normal health. Of other suggested causes, the so-called laxity of the submucosa which is said to permit movement of the mucous membrane on the muscularis cannot account for more than a mere pouting of the mucous membrane, for the laxity cannot be more than the blood-vessels which pass through the submucosa will allow. Laxity of the connections of the rectum with the sacrum is also given as a cause of prolapse in infants. But as will shortly be shown, there is no greater laxity in these attachments than there is in the adult.

A sagittal section of the pelvis at birth shows that the position of the rectum relative to that of the bladder (and of the uterus in the female) differs from the adult relation in that the latter organs are placed at a higher level in association with the small capacity of the pelvis. In other

words, the rectum at birth is already in a position of mechanical disadvantage, inasmuch as it occupies a lower site than the other organs which in later life, also descend entirely into the true pelvis. Since the plicæ transversales, or valves of Houston, are present in embryonic life, the exact position of the rectum relative to the vertebral column may be ascertained. In the dissection of a series of pelves of new-born infants I find that the third or great valve of Houston lies opposite the fifth piece of the sacrum on the average, the variation being from the level of the fourth sacral to that of the first coccygeal vertebra. Hence at birth the third plica transversalis has already reached its adult position. This is the most constant portion of the rectum, and was therefore chosen as the indication of the true level of the organ compared with the vertebral bodies. Since I drew attention to this point,⁸ it has been brought out again by F. P. Johnson in a paper which gives additional information on the development of the rectum² beyond that which lay within the scope of my observations.

This site is, as one would expect, retained during childhood.⁵ Hence one may say that while the rectum in the infant occupies the same position relative to the vertebrae as in the adult, yet it is in a position of greater mechanical disadvantage from the higher position occupied by the bladder and uterus, as well as from the straight character of the sacrum, which cannot relieve the organ from pressure of overlying viscera as can the more curved sacrum of the adult.

Next one may consider the question of laxity of the attachments of the rectum to the sacrum in the infant.

The fascia propria of Waldeyer, apart from any continuation upwards into the fascia of the pelvic mesocolon,¹⁰ has a definite attachment (rectosacral aponeurosis) to the hollow of the sacrum between the third sacral foramina,⁴ forming a capsule for the rectum.³ The lateral parts of the rectosacral aponeurosis comprising the fibromuscular tissue around the middle hæmorrhoidal vessels and visceral pelvic nerves has, in view of its relation to the last named, some fixation to the sacrum in the region of the second, third and fourth foramina (rectal stalks). It is to be remembered that only the third and fourth sacral nerves actually send branches to the perineal chamber of the rectum, but there is no anatomical subdivision of the fascia surrounding the several nerves. These nerves, vessels, and surrounding fascia correspond to the substance of the mesenteries by which other parts of the alimentary canal are supported. In a number of cases I made dissections of the rectal stalks in new-born infants and found that the stalk, simply isolated and as yet undissected, measures about half the length of the contained vessels and nerves if they are freed from vascular and perineural fibromuscular tissue. I found that these proportions obtained also in the adult specimens used as controls. For example, in a new-born female child the sacrum of which measured 42 mm. in length, the isolated but undissected

rectal stalk measured 12 mm, while the dissected stalk consisting of nerves only was 22 mm long. The corresponding measurements in a male infant, the sacrum of which measured 40 mm, were the following: Undissected stalk, 12 mm, nerves only 25 mm. This comparative length of nerves and vessels allows some possibility of movement of the rectum as a whole, but so long as they remain uninjured, the movement of the organ is necessarily limited. In no case did I find the dissected rectal stalks long enough to allow the great valve of Houston to descend so far as the anus. In the female infant above mentioned, the distance from the great valve to the mucocutaneous anal junction was 36 mm, in the male, 37 mm. With a maximum length of rectal stalk of 22 and 25 mm, respectively, it is plainly seen that prolapse must be limited. The same approximate proportion is found in the adult.

In a male subject of thirty-five years of age, in which the dissected rectal stalks measured 60 mm, the sacrum was 115 mm in length and the distance from the great valve of Houston to the mucocutaneous anal junction 75 mm. The length of the dissected rectal stalk is approximately one-half that of the sacrum. In a female twenty-five years old it was 55 mm in length, the sacrum being 110 mm long. The undissected rectal stalks in the adult male cited each measured 30 mm, in the adult female, 20 mm.

As a result of the investigation, I find that in the adult the increase in possible length of the rectal stalk corresponds roughly with the amount to which the rectum can be drawn out of a perineal wound when the levatores ani, but not the stalks, have been completely severed. In the infant the length of the rectal stalks and their increase in length on dissection correspond proportionately to the condition found in the adult. There is, therefore, no greater laxity of the rectosacral attachments in the infant than in the adult. In both there is sufficient play in the rectal stalks to allow a certain limited prolapse in the presence of other accessory causative factors and without damage to the nerves and vessels themselves. In such instances, the prolapse must obviously be temporary, and it would appear unnecessary to resort to operative measures for its treatment.

SUMMARY

1. As estimated by the position of the great valve of Houston, the rectum at birth presents practically the same relation to the vertebral column as in the adult.

2. Similarly the rectal stalks are of the same proportionate length in the infant as in the adult. Hence in the former there is no greater laxity than in the latter.

3. The only anatomical characters which can be of special importance in infantile prolapse are the comparatively straight sacrum and consequently more vertical rectum.

RECTAL PROLAPSE OF INFANTS

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SARCOMA OF THE PROSTATE

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Age of Incidence—Of the total of sixty-two cases recorded, 20, or nearly one-third, occurred before ten years of age, 45, or three-fourths, occurred before the cancer age of forty years, and 80 per cent occurred before the usual age of prostatic adenoma (fifty years). These facts alone are of great diagnostic value. Therefore, a prostatic tumor occurring before fifty years of age is possibly sarcoma, and one occurring in adolescence is probably of such a nature.

The most common symptom was obstruction either of urination, or defecation, or both. This stage was, for the most part, rapidly reached, after the first signs of difficulty of urination, i.e., in one to two months, and was thereafter a permanent symptom.

Pain in the younger patients was less marked, being absent in many while in those past fifty years of age it was more marked. Perineal fullness and tension was a frequent complaint.

Rectal examination revealed a body compositely described as large, smooth, moderately firm, with uniform consistency, elastic, "balloon-like" (Powers¹), and only moderately, if at all, tender.

Differentiation must be made from syphilis, tuberculosis and cancer.

With such a prostatic enlargement, a history of congenital or acquired syphilis, a positive Wassermann reaction, or other evidence of congenital or acquired lues, render the therapeutic test necessary. A tuberculous prostate does not become as large as a sarcomatous, has a varying consistency with small nodules or soft areas scattered over it. One or both seminal vesicles will be felt to be enlarged, nodular, nodules may be felt in the epididymis or vasa and there will be other evidence of tuberculosis. Cancer of the prostate usually occurs later in life than sarcoma, is smaller, has the well-known firm, nodular consistency, is irregular, more fixed and the interlobular sulcus is early obliterated. It spreads beneath Denonvilliers' fascia. In sarcoma the tumor is immediately and abruptly encountered by the examining finger.

Pathology—Round and spindle cells have formed the majority of these tumors, though myxo-, angio-, lympho-, chondro-, myo- and fibrosarcomas have occurred among them. Three cases of rhabdomyoma are improperly included.

Treatment—Extirpation through either the suprapubic or perineal route followed by radium treatment is indicated.

Paschkis and Tittinger² drained the bladder, and inserted into the fistulous opening a tube containing 4.7 mm of radium for twenty minutes.

This treatment was repeated twenty-one times at two-week intervals. The swelling disappeared and all signs of the tumor were gone, but the authors do not regard the tumor as cured.

In excessively large tumors like that of MacGowan the perineal route seems preferable.

With the possible exception of the case reported by Paschke and Tittinger, there has been no case of cure recorded, all dying of recurrence within four years.

Within the last two decades the prostate has no doubt been as thoroughly worked over pathologically as any tissue of the body. The fact that only 62 cases have been reported proves its rarity, and some of these are not genuine. We find it first mentioned by Stafford⁴ in 1839. Jolly,⁵ in 1869, collected 41 cases. The first careful tabulation of reported cases was made by Buickhardt,⁶ in 1902, who collected 24 cases. In 1908 Powers¹ reported a case, carefully reviewed the literature, and tabulated 22 cases. Von Firsch,⁷ in 1910, collected 35 cases. Descum,⁸ in 1912, gave an excellent review, tabulating 41 cases.

Of 58 observations which Pioust and Vian⁹ made in 1907, they make four groups:

1 Secondary sarcoma	6
2 Doubtful cases	4
3 Probable cases, but lacking histological examinations	14
4 Absolutely certain cases	34

In conclusion the age of incidence, the rapidity of growth, the balloon-like feel of uniform consistency, the chief symptom obstruction to urination, strongly suggest sarcoma.

To the above list the author appends the following personally observed case in its entirety, as the apparent rarity of this condition would seem to justify its report.

The patient was thirty-three years of age, single, with a family and past personal history having no bearing on his present condition. He denied having had any venereal infection.

The present illness began May 15, 1916, when he first noticed that unusual straining was necessary to empty his bladder. Two weeks later marked the beginning of acute retention and of catheter life. For seven months he catheterized himself five times daily, on four occasions a small amount of blood being noticed. He had no pain in the lower abdomen, along the urinary tract, nor about the perineum. The bowels were regular. Urinary obstruction and loss of about 20 pounds in weight in nine months were his only symptoms.

General examination was entirely negative, showing a very well-developed and well-nourished man.

Rectal examination revealed a very large, smooth, elastic-feeling body, of uniform consistency, not tender, slightly larger to the right than to the left. The examining finger could not reach above

it It was bimanually palpable, slightly movable and limited in outline

The left kidney was palpable, tender and seemed enlarged The right kidney was negative

Red blood count, 5,744,000, white blood count, 12,000 Wassermann negative on two examinations

His urine was æcid, 1000, albumin double plus, sugar none, contained many pus cells, a few red cells and no casts With the amount and duration of the retention, it was concluded that there was some back pressure on the renal secretion The "Thalein" output in three days was as follows A retention catheter was placed on the first day after the "Thalein" test

	January 25th	26th	28th
1st hour	100 c.c. trace	170 c.c. 26 per cent	475 c.c. 66 per cent
2nd hour	50 c.c. 12 per cent	100 c.c. 23 per cent	175 c.c. 27 per cent
3rd hour	25 c.c. 6 per cent		
	175 c.c. 18 per cent	270 c.c. 49 per cent	650 c.c. 93 per cent

This is striking evidence of the value of a retention catheter in this type of prostatic obstruction

Operation (January 29, 1917) —Suprapubic incision On opening the bladder a rosette two inches in diameter consisting of œdematous-looking papillomata from pea to large bean size surrounded the inner urethral orifice This came from the apex of the trigone The main tumor could be felt bimanually beneath this

The entire growth together with this rosette was readily enucleated as one piece (Figs 1 and 2), leaving a very large cavity separated from the rectal cavity by a very thin wall which was not torn Three purse-string sutures were placed, obliterating this cavity and controlling the bleeding Closure with suprapubic and catheter drainage

Post-operative care Three-hour boric acid irrigation for first day Removal of catheter on second day On the fourth day a distinct fecal odor was evident in the urine, from the suprapubic tube This continued for a week, with cloudy urine, and ceased spontaneously, no sign of urinary discharge into the rectum Convalescence was uninterrupted and the patient was up about the ward, passing urine tissue only

Cystoscopy six weeks after operation showed a completely healed prostatic urethra and trigone, with some large, bulbous œdema At one place this appeared so large that a section was taken for examination, which, however, showed inflammatory through the urethra in two weeks

The patient being a ward case, he was lost sight of, but three and one-half months after operation, he returned with marked recurrence in the prostatic region His general condition, however, was very good

Pathologic examination showed the tumor to be sarcomatous (Figs 3 and 4)

FIG 1

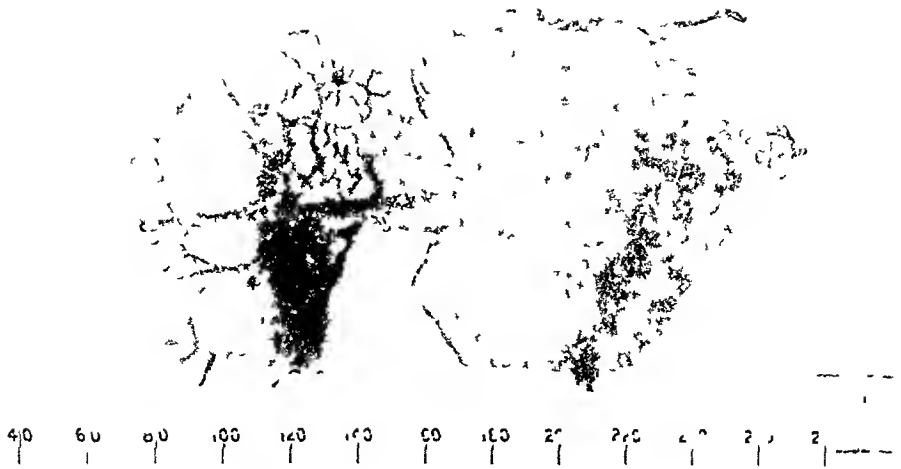
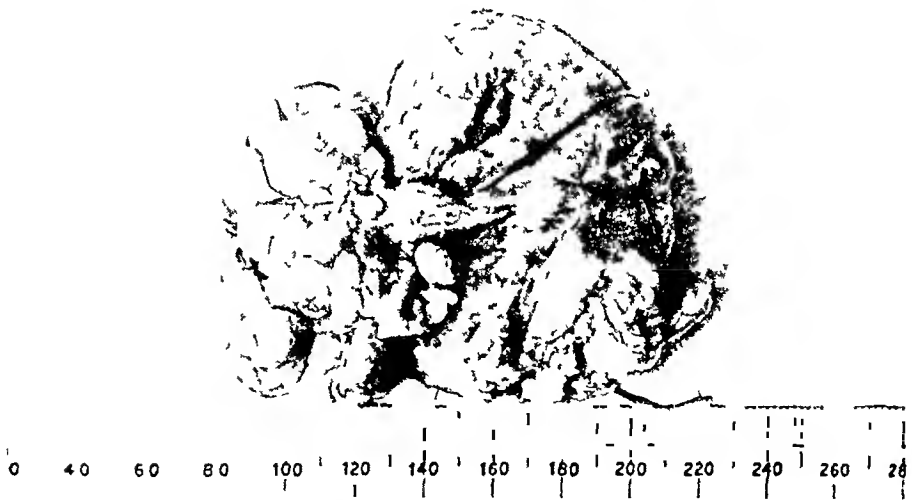


FIG 2

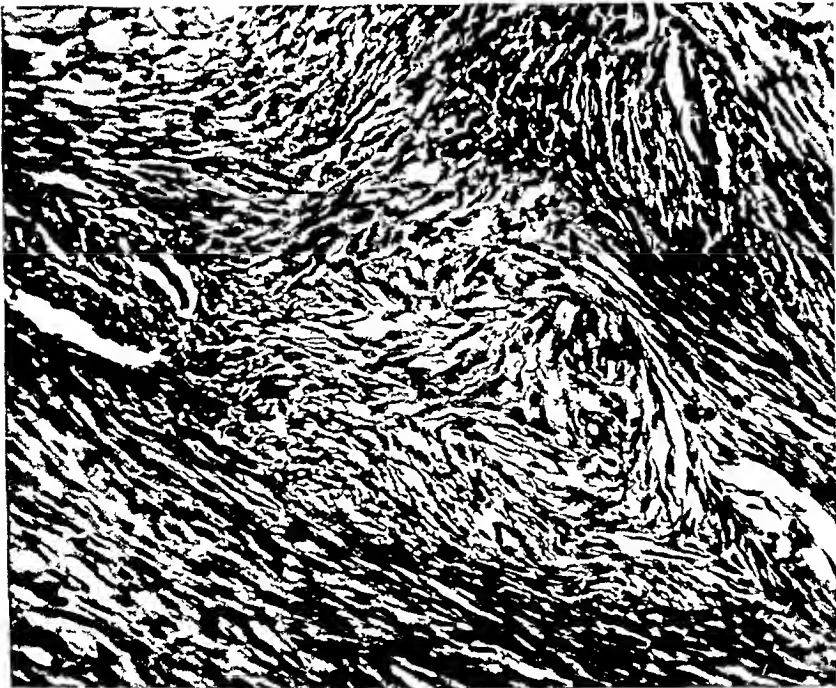


FIGS 1 AND 2 —Showing gross specimens

FIG 3



FIG 4



FIGS 3 AND 4 —Microphotographs of tumor Diagnosis Sarcoma

SARCOMA OF THE PROSTATE

Dr B B Barringer of the Memorial Hospital in New York was kind enough to give him radium treatment

The following is a report of the examination made by Dr B B Barringer on May 15, 1917

"Very large tumor can be felt Growth of prostate on left side, possibly not as much on right side

Physical Examination—Well developed, well nourished young white man, not acutely ill Pupils react sluggishly, breath foul, tongue fairly clean Abdomen normal above umbilicus Between the umbilicus and the symphysis pubis there is a scar four to five inches long About one inch from lower end of the incision the scar is spread apart by a circular scar as of abscess, the diameter of which is the size of a nickel No discharging sinus Around this circular scar as a center there is a hard indurated mass the size of an orange not very sharply circumscribed The skin is freely movable over this mass, except at scar where it is adherent The mass is not tender and there are no inguinal enlargements Otherwise negative

Treatment—Radium emanations Needle inserted into the prostate, for six hours "

Autopsy by Doctors Ewing and Stone, July 12, 1917

"Sarcoma of the Prostate—Metastases in the Liver Suppurative Pyelonephritis

Body—much emaciated Decomposed Skin—ulcerated over large tumor filling pelvis Lungs—free, congested, normal Heart—soft, normal Spleen—normal Liver—several large circumscribed, soft, yellowish, protuberant tumor masses $\frac{1}{4}$ cm in diameter throughout the liver

Pelvis—filling the pelvis, adherent to the walls of the pelvis and abdomen, and extending along the mesentery of the colon, forming a mass 15 cm in length, surface lobulated, consistence soft and elastic, color yellowish, is a tumor mass emanating apparently from the tissues about the bladder The tumor constricts the rectum It is in places ulcerated and invaded by tumor tissues

Bladder—mucosa highly inflamed Invaded at one point from without by tumor tissue Otherwise intact

Prostate—missing Tumor contains some dilated veins with thrombi and a few large cysts

Kidneys—Both kidneys are the seat of intense suppurating pyelitis and nephritis in early stage

Stomach—normal Pancreas—normal Genitalia—right testis small, hypertrophic, normal Left testis—appears normal "

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ABSCCESS OF THE PROSTATE

BY ALEXANDER RANDALL, M D

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THE subject of abscess of the prostate may seem to many but a trite one, and undoubtedly the majority look upon it as principally a condition limited to the category of a complication of acute specific urethritis. That such is not the case but a cursory review of the literature is necessary. The interesting case of Lydston where the condition so closely simulated prostatic hypertrophy that even at suprapubic cystotomy it was unsuspected, and spontaneous rupture took place during a period of bladder drainage, or Harlow Brooks's case with its course so typical of enteric fever that for four weeks the true condition was completely masked, and more recently Bugbee's report of five cases seen as a complication of influenza during the recent epidemic, all show the deviation from the usual that prostatic abscess can manifest and broaden the field of possibilities calling for differential diagnosis.

Similarly in the short series of sixteen cases that it has been my opportunity to study, there have occurred certain features of unusual interest in diagnosis, making them worthy of a report at this time.

Prostatic abscess calls, in the first place, for an acute infection of the acini of the gland by a virulent organism of the pus-forming type, and we recognize in the beginning that this infectious process may manifest itself in four different degrees of severity, leading on the one hand to a limitation of the infection at any one of the stages, or, on the other hand, to a continuation of the process to a breaking down of tissue and the formation of an abscess cavity. These four forms of involvement from the time of the entrance of an infectious agent are (1) The catarrhal, (2) the follicular, (3) the parenchymatous, (4) the periprostatic, and it is only when the infecting agent is overcome at an early stage that the process does not proceed from the one to the other with a culmination in the formation of an abscess instead of resolution.

During these periods of acute involvement we have but the palpating finger to guide us in interpreting the stage of the disease, and to determine when an actual pus cavity has formed. Here I cannot but feel that a close parallel can be drawn to a somewhat analogous infection, *ie*, acute epididymitis, where it was long considered that only infrequently did actual abscess cavities form, until Hagner, in operating upon all such cases, demonstrated that pus, in macroscopically visible quantities, was present in 80 per cent, and as in epididymal so in prostatic infections, especially when gonorrhœal, is it probable that macroscopic pus is pres-

* Read before the Philadelphia Academy of Surgery, November 3, 1919

ent much earlier than now believed, and that early and free incision with drainage should be instituted as soon as diagnosis is made, so as to conserve the vital function

It is the tendency of most physicians to feel in regard to prostatic abscess much as they do towards every acute ailment of the active generative organs in the male, that any infection of a pus-forming character is, *ipso facto*, of gonorrhœal origin the contrary being shown by this short series of cases that I have personally observed is one of the interesting features to which I draw your attention

The series comprise sixteen cases, eight of them were associated with the presence of the gonococcus and a history pointing to this infection being the cause of the abscess formation. An equal number, eight, were non-specific in their origin and form an interesting diversity of causes. Analyzing first those that were definitely post-gonorrhœal, we find that they, too, have interesting features that I will enumerate but briefly

In one an interval of twelve years had passed since his acute urethritis, the patient had been married and left a widower, had during this time suffered from a mild, thoroughly chronic discharge, and after an alcoholic debauch, devoid of sexual exposure, he developed an acute urethritis. Gonococci were present, and shortly thereafter a prostatic abscess. Of these eight post-gonorrhœal cases but one was operated upon with drainage of the abscess. In four patients the course was uneventful, and early subsidence of all symptoms was followed by an apparent complete resolution without rupture. This was a most happy outcome for one of them, for he had multiple œsophageal strictures of small calibre from typhoid ulceration, and a urethral stricture of almost filiform size. In two others, who went to complete resolution, an acute epididymitis was associated and the prostatic involvement was especially marked on the same side as the epididymal. The remaining one where resolution took place was first seen under circumstances that countermanded operative interference. In the sixth post-gonorrhœal case, spontaneous rupture into the urethra occurred twelve hours after diagnosis was made, with a rapid subsidence of all symptoms. In the seventh, the abscess was purposely ruptured by a sound in the urethra—a most unsurgical procedure—and the eighth case was seen in consultation and lost to further study, although reported to have resolved without rupture

So we have eight cases clinically diagnosed as prostatic abscess, secondary to an active gonorrhœal arthritis. One was operated and drained perineally, one was ruptured on a sound in the urethra, one ruptured spontaneously, four passed to complete resolution under local treatment, and one was lost to further observation. The series is too small to draw deductions from, but it does point out that there are varying degrees of pathologic involvement from this infecting organism. That in some with good judgment you can save your patient an operation, while in others resolution cannot be expected, and for them we know that it is better to operate and drain perineally than to allow urethral rupture. This group includes one where personal desire countermanded an operation definitely indicated. There was a large fluctuating mass in the left lobe, temperature of 102.5, white blood cells, 15,600, urinary strangury, chills, etc. Local treatment was instituted, two days later the temperature was falling, and

the white blood cells were 14,200, the following day the temperature was normal and the white blood cells 12,400, and the next day it was down to 11,000 with the temperature remaining normal. His subsequent recovery was perfect, complete resolution followed, with certainly no rupture, and it has been surprising to see in the four cases so treated what rapid and complete resolution can take place. The right lobe was affected twice, the left lobe a similar number of times, and four times the involvement was general. Gonococci were present in seven cases from the urethral discharge, and were demonstrated in the one case operated upon.

Though the course pursued in these cases, with the exception of one, was non-operative, and though the results could possibly be used as an argument in favor of local, palliative treatment, the after-results oftentimes seen at intervals of years, from cases which were allowed to rupture into the urethra spontaneously, or to resolve with a chronic prostatic infection present, show conclusively that here, as in similar conditions elsewhere in the body, where pus has once formed, surgical intervention and proper drainage afford the patient a surer chance of a complete physiological restitution of function.

Frequently we see cystoscopically a condition in the prostatic urethra, first pointed out by McCarthy, where large scarified prostatic duct orifices penetrate to unknown depths into the gland tissue. These are now known to be the residuum of such infections, and as such form almost permanent foci of infection due to poor drainage and scar tissue, and incapable of ever returning to a normal state. Without doubt, such permanent damage may be avoided by early operative interference, and the degree to which such injury may develop will be illustrated by two of the cases about to be reported in the non-specific group.

In the second group of eight cases gonorrhœa played no antecedent rôle. These are by far the more interesting cases. The possibilities as to origin of infection, the type and virulence of the organism, the ofttime complete masking of all symptoms pointing to the actual seat of the disease, the rapidity of some cases and the latency of others, make an ideal field for differential diagnosis.

Of these eight non-specific cases, instrumentation was responsible in four of them. The first consulted a specialist for a slight mucoid discharge. For a month he was given prostatic massage and "deep injections." Following one such treatment he developed within forty-eight hours all the symptoms of an acute infection of the prostate—there was a chill, fever, with a temperature of 103, hæmaturia, and vesical tenesmus. The diagnosis of an abscess was easily made by rectal examination. An acute epididymitis developed the following day. Palliative treatment was requested, and under local applications complete resolution took place slowly and without rupture of the abscess. In the second case, age twenty-eight years, there had been a gonorrhœa nine and two years previously. Three weeks before hospital admission, after a walk in the cold, he developed a chill and fever, with a temperature of 103, and pain in the right chest. Treatment was given by his physician and two days later the chest pain was gone. Ten days before admission he developed retention of urine following the passage of a sound, which had been unsuccessful and had caused bleeding. Pain began within twenty-four hours and

ABSCESS OF THE PROSTATE

steadily increased. On entrance to the hospital his temperature was 104, and his white blood cells 19,600. The entire prostate was involved in the abscess formation and presented a mass extending as high up as the finger could reach. Operation showed a large pus cavity especially located in the right prostatic lobe, with a marked indurated cellulitis extending all the way down into the right crus penis. The organism was the *staphylococcus pyogenes aureus*.

The third case was seen while in the field with the A. E. F.—a man, fifty-two years old, who had been told that he should have a sound passed every month because of an old stricture. His medical officer did this for him, and five days following the third passage of a sound there was a very gradual onset of acute symptoms, which in six days developed a fluctuating mass in the prostatic region. On account of surrounding conditions a palliative course was pursued for seven days in the hope that resolution would take place. However, at the end of this time the patient's condition demanded intervention, so under morphia and cocaine anæsthesia perineal incision and drainage were performed, and a complete recovery was obtained in seventeen days. This was a most satisfactory case, as an invaluable officer was saved to the division for tremendously important work at the front in the September and October campaigns. Unfortunately the origin was not identified.

The fourth (now a patient in the hospital) gave a most unusual history. He was doing some heavy work in the army when seized with a sharp pain in the right groin. Hernia (according to him) was diagnosed, but unoperated, and in three weeks he was well. Before leaving the hospital in October, 1917, he was ordered to take a permanganate of potash irrigation. He remonstrated, not seeing its necessity, and was ordered to do as told. Some bleeding followed this, and he had complete retention for five days, having a catheter passed once in each twenty-four hours. On the fifth day he was seized with chill, fever and severe pain in the rectum, and was immediately operated upon for prostatic abscess by a perineal incision. The patient states that he "came to" six weeks later in December, 1917, and was told that he was a bleeder, and had had two transfusions to save his life. He was then voiding through his perineal incision and his urethra. In January, 1918, a sudden hemorrhage from his incision called for a third transfusion. In March a catheter was passed and again bleeding occurred of such alarming character that a fourth transfusion became necessary. Following this he developed a left epididymitis, which suppurated and was incised, and following this operation he first passed urine per rectum. Typhoid at fourteen, scarlet fever at eight, several teeth pulled as a child with no hemorrhage, but in 1908 an extraction of a tooth was followed by bleeding requiring packing, and in 1915 had a severe "nose bleed," brought on by sneezing, which lasted four days. Had had an appendectomy the same year without incident. This patient had a fistula certainly a centimetre in diameter extending directly through his prostate into his rectum. Three-quarters of his urine went through the fistula. He had bladder continence. So with such a history and a coagulation time of thirteen minutes, he will be left alone.

Again we have a case of a boy of twenty-three years, who entered the dispensary complaining of his inability to properly control his urine. For many years, in fact, as long as he could remember, he dribbled urine, which he now says he knows to have been due to the overflow of retention. This he has relieved during the past few years by the judicious use of a catheter. One and a half years ago he developed a swelling in the right lower abdomen, practically symptomless, which finally ruptured and discharged a large quantity of pus through the urethra. During the healing of this condition there developed an opening into the rectum, for since that time, when he gets over-distended, urine in small quantities passes into the rectum. There is never any feces or gas mixed with his urine. He has rectal control, in fact, is constipated.

Cystoscopy (May 4, 1916) Bladder normal, urine slightly cloudy, left ureteral orifice not demonstrable In the posterior urethra a large cavity was found extending back into the region of the right prostatic lobe, from which can be seen protruding a mass either fecal or calcareous There is a small pocket also on the left

Cystoscopy (May 12, 1916) Two calculi were found in the bladder They were crushed with the cystoscopic rongeur The prostatic cavity was clear

Cystoscopy (May 19, 1916) Two more small stones seen in the prostatic pouch These were picked up with the cystoscopic rongeur and placed in the bladder, where they were crushed at leisure

Cystoscopy (May 24, 1916) Last calculi crushed Reexamined January 17, 1917 Condition as before, no further stone formation Patient is still using a catheter

This boy's condition was due to *spina bifida*, demonstrated by X-ray, his sphincteric inhibitory fibres being undeveloped His abscess was caused by his catheterization

These last two cases illustrate the unfortunate results that may ensue from injudicious instrumentation, and the most distressing complication from prostatic abscess. In the former it was felt that so long as his vesical control was perfect from the good action of his internal sphincter, he had best be left alone, in the face of his history of bleeding In the second, patient's undeveloped nervous system, though responsible for his trouble, was likewise considered his saving, as his spastic internal sphincter controlled his urine and any operative interference might make a persistent dribbler of him

Again we have a student, thirty years of age, who during the preceding summer was studying abroad, and for recreation used to row a great deal, and as a result had a series of sores The first were undoubtedly due to the rubbing of the boat seat—a condition so frequently seen in oarsmen—but they were succeeded by a series of similar infections elsewhere about the body, in several of which on culture the staphylococcus pyogenes aureus was the causative agent About two and a half months after the first of these local infections, and after his return to the States, he was suddenly seized with rectal pain, chills, fever and a high leucocyte count Prostatic abscess was diagnosed and operation proved the same to be the cause The infecting agent was still the staphylococcus pyogenes aureus No venereal infection

The fifteenth case was that of a young physician No venereal history He had been in slightly lowered condition of vitality and health from his active rural practice, when he suddenly felt faint Later he had a chill and was feverish The only other promonitory symptom was that on the day before he had noticed some scalding on urination and found his urine scant and highly colored He had been constipated for several days prior to these symptoms His temperature was elevated on the above day of onset, and the following day it had reached 102, with pains down the legs, in the back and headache There was a gradually increasing pain in the rectum The following day, forty-eight hours from onset, after straining at urination there was a slight discharge, which increased rapidly at each urinary effort, and towards evening after one urination there was passed out a lump of mucus, followed by a profuse purulent discharge and blood Condition from then on improved to complete cure Smears from the discharge and also a culture showed *B. Coli Communis*

The last case was seen on the Urological Service at the Johns Hopkins Hospital The man was seventy-two years of age and gave a very typical history of gradual vesical obstruction due to enlargement of the prostatic gland over eight years' duration and with gradually increasing symptoms Four days before his admission complete urinary obstruction occurred, associated with an elevation of temperature and very severe chill Catheterization for the first time was easily performed, but without greatly easing the patient's discomfort For fifteen days regularity of recurrent diurnal chills of the most intense type and subsequent

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fever elevation made the medical consultants feel practically certain that the patient had malaria, no matter what else he harbored, and this assumption was strengthened by the Virginia home of the patient, as also his past history. An elevated white blood-cell was against this diagnosis. Catheterization was easy, and even cystoscopy was performed. By rectum there was a large smooth prostate in no wise especially symptomatic or suspicious. He was treated expectantly. His temperature chart broke all the high and low records. At one time it varied from 96 at noon to 107.2 at 7.30 P. M., falling from there to 96.8 by 8 A. M., an excursion upward of eleven and two-tenths degrees and a fall of ten and four-tenths in the space of twenty-four hours. It was at this point that the surgeon stepped in, and knowing that there was urinary obstruction present—everything else being uncertain—started to perform perineal prostatectomy and drained a large prostatic abscess. The culture in this case showed *B. Coli*.

Summarizing the non-gonorrhœal cases one underwent resolution; one ruptured in forty-eight hours into the urethra, four were operated upon by perineal incision, and two presented the sad after-results of such infections poorly handled in having a urethro-prostatico-rectal fistula. In two cases *B. Coli* was the infecting organism, and in a similar number *staphylococcus pyogenes aureus*.

In regard to the mode of approaching a prostatic abscess for drainage, there are four possible and recommended routes. First, the purposeful rupture on a sound in the urethra, a procedure blind, dangerous, hemorrhagic, destructive, and non-surgical in the extreme. Secondly, the drainage into the rectum, again non-surgical, and because of the tension of the parts offering very poor drainage. Thirdly, there has been recently proposed a perineal incision into the urethra, followed by the introduction of the finger into the posterior urethra and digital rupture of the abscess through the posterior urethral wall. As above pointed out, the future repair of such openings is oftentimes the cause of persistent sinuses in the prostatic urethra and the cause of chronic prostatic irritation, moreover, the author of this recent article advocating such an approach drains by passing a tube into the bladder and allowing the purulent discharge to drain around this to the perineal dressing. Again I cannot refrain from calling this method non-surgical, for it certainly opens up avenues for the infection to spread that are absolutely unnecessary.

The choice, then, remains to expose the posterior surface of the prostate through the perineum, incise directly and under the eye's guidance the actual seat of infection, place therein tube and gauze drainage, the whole performed without injury to either the urethral or the rectal surfaces, they being left to perform their respective functions as usual, and without danger to their normal continuity.

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CERVICAL EROSIONS

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THE term cervical erosion, like many other names used in connection with this condition, such as mucous patch, cervical granulations, endocervicitis, cervical catarrh, etc, is not accurately descriptive of the lesion to be discussed. When applied to a pathological process the term erosion has ever suggested a raw or ulcerating surface, but such is not found present in the condition under consideration. Ruge and Veit first called attention to the adenomatous proliferation which takes place in the cervix, and later Eden and Lockyer have suggested that "proliferative adenoma of the cervix" would be a better and more descriptive term. The gross appearance of the cervix when presenting this condition resembles somewhat a granulating surface when viewed through the speculum. This fact has probably played an important part in maintaining the use of the expression.

In the normal cervix the line of demarcation of the external os is sharp between the mucous membrane lining the cervical canal and that covering vaginal portion. The former is composed of connective tissue over which is placed a single layer of columnar epithelium of the mucous type. The free margin of the surface is distended with secretion. Within the deeper portion of the membrane are found the cervical glands lined with the same type cell. These glands secrete a thick tenacious mucus into the lumen of the canal. In the foetus this columnar epithelium extends beyond the external os and it has been suggested by Fischel that the failure of this to disappear may account for the occurrence of congenital erosion.

Laceration of the cervix during childbirth is the most common cause of erosion. Rarely this condition may follow a plastic operation on the cervix whereby the normal anatomical relation between the mucous membrane lining the canal and that covering the vaginal portion is deranged so that the columnar epithelium is rolled out beyond the normal line of separation. The small abrasion or superficial tear seldom enters into the causation of erosion, since the squamous epithelium readily covers such surfaces. The deeper lacerations of childbirth which are more common than we are wont to recognize, and especially when bilateral or stellate, cause in most instances eversion of the torn lips so that the lining membrane of the canal becomes exposed in the vagina. When unrepaired the cervical membrane in most instances does not return to its former position. This misplaced membrane of the canal, which normally

is bathed in the mildly alkaline secretions of the uterus, now comes into constant contact with the acid reaction of the vagina. Secondary infection, either acute or chronic, is a most common complication. The friction of the vaginal walls associated with the above mentioned sources of irritation produces an increase of the submucous stroma plus an adenomatous proliferation of the glandular structures. As the condition progresses the columnar epithelium tends to extend beyond the margins of the tear, carrying with it the mucous glands, so that their ducts open on to that portion of the misplaced mucous membrane now exposed within the vagina. The extent to which this occurs varies with the nature of the tear, the presence or absence of infection, and the length of time the condition is allowed to remain untreated.

Gonorrhœal infection of the cervical canal even in the absence of laceration may set up sufficient inflammatory reaction within the submucous structures to produce a swelling and œdema which will tend to push the membrane of the canal past the external os. As this becomes more and more chronic we find a marked increase in the number and size of the glands.

Under the microscope the area of erosion is covered with a single layer of columnar epithelium. The continuity of the surface is interrupted by the ducts of the glands. These glands become greatly enlarged and in some instances extend for a considerable distance into the underlying connective tissue. Very often they are of normal size, but considerably increased in number. In many specimens the glands are found dilated and filled with mucus—the columnar epithelium being swollen and distended with secretion. When this secretion does not find ready exit via the ducts of the glands the lining membrane may become flattened because of the increase in pressure produced with the increase of the material. An inflammatory reaction may or may not be found within the stroma. Eden and Lockyer have applied the term “follicular erosion” to the type of cervix which displays a retention of the secretion associated with a dilatation of the glands. They suggest “papillary erosion” for the type in which the increase in stroma tends to push outward villous or papillary projections covered with a layer of columnar epithelium. It is this type which strongly suggests a granulating surface when examined per vaginam. When both of the above types are found in the same cervix they would use the term “simple erosion”.

Should a section of the cervix be cut for microscopic examination so as to show the junction between the true vaginal portion and the erosion proper, it will be noticed that the misplaced membrane bulges out past a sharp line of demarcation, while on the other end the process fades gradually into the membrane still lining the cervical canal.

The erosion in some instances after becoming more or less chronic tends to heal. The squamous epithelium in some cases extends over the area of erosion overriding the columnar epithelium in such a manner

that it causes these cells to entirely disappear, resulting in a subsequent atrophy of most of the glandular elements. As this change progresses it is associated with a contraction of the stroma and there results a complete obliteration of the channels of exit with the formation of retention cysts, of varying sizes, to which the term Nabothian follicles has been applied.

To the examining finger the irregularity in contour of the cervix when lacerated can be distinguished readily. The erosion feels soft and velvety. This is even more pronounced in the distinctly papillary type which when viewed through the speculum resembles very closely a granulating surface. The surface is covered with a thick tenacious secretion. In the non-infected cervix the leucorrhœal discharge is clear and glistening or whitish and otherwise muco-purulent or purulent. Although the surface bleeds rather freely when manipulated with the finger or instrument, it is never friable. The condition when chronic presents a cervix which is more or less hardened and fibrous. If the attempt to heal has progressed sufficiently to cause the production of Nabothian follicles there is a shotty-like sensation transmitted to the examining finger. To the eye these appear as bluish thin-walled cysts extending beyond the surface of the cervix, and when punctured are found to be filled with thick mucus.

The most common symptom is leucorrhœa, varying in amount and color. The congestion attendant with menstruation tends to increase this discharge just prior to the appearance of the flow. Many patients complain of menorrhagia, which is due in most instances to an associated subinvolution of the uterus. The chances of the patient becoming pregnant are lessened. However, should this occur, abortion is not infrequent. When questioned the patient will usually state that she suffers from a sensation of weight in the pelvis together with one or more of the reflex disturbances encountered during the course of uterine pathology.

In differentiating this condition from malignancy it should be remembered that while erosion of the cervix bleeds rather freely, it is never friable excepting in those cases in which actual malignant change has occurred. When doubt exists a diagnostic section should be removed prior to performing a radical operation. Tuberculosis of the cervix is not of frequent occurrence, and when it does occur the lesion is softer, bleeds less readily, but has a tendency toward hemorrhage in the absence of examination. There may also be complete destruction of tissue with excavation of the cervical canal and vaginal portion of the cervix. During the later stages of tubercular infection the discharge becomes very profuse, purulent and offensive. The history and general appearance of the patient together with the findings in the gross lesion should render the differentiation comparatively simple. When syphilis is suspected the Wassermann and the history of the case should aid in clearing up the diagnosis. Here, as in tuberculosis, the tendency is toward destruction of tissue and not proliferation as seen in most cases of erosion.



FIG 1 —Low power —Cervical erosion of "follicular type" showing marked dilatation and accumulation of secreted material



FIG 2 —Low power —Cervical erosion, 'papillary type' showing projections of stroma covered with a single layer of columnar epithelium



FIG 3 —Low power —Cervical erosion simple type showing small papillary projections with dilatation of glands



FIG 4 —Low power —Cervical erosion Marked follicular type with beginning formation of retention cysts



FIG 5 —High power —Cervical erosion showing attempt to heal Squamous epithelium is seen dipping down the side of duct in attempt to close over the area

CERVICAL EROSIONS

The treatment of cervical erosion when seen early is rest. The patient is instructed to refrain from coitus. The local medication consists in combating whatever infection is present. In some instances it is advantageous to render the vaginal secretions less acid by the institution of some mildly alkaline douche as a daily routine. In certain cases chemical cauterization may be used with some improvement. Curettage has improved the condition in many patients. This procedure must be thorough and succeed in removing all of the damaged tissue so that the normal relationship of the structures entering into the formation of the external os is obtained. In some instances when the condition is of long standing associated with considerable tissue change, plastic repair of the laceration is indicated. When the process is markedly chronic and the cervix is fibrous and the clefts formed by the old lacerations are partially filled and surrounded with dense connective tissue, the treatment of choice is amputation with the formation of a new external os.

SUMMARY

1 The term cervical erosion, like many other names similarly used, does not adequately describe the condition.

2 "Proliferative adenoma of the cervix," as suggested by Eden and Lockyer, would seem to be a better and more descriptive term.

3 Three distinct types are encountered—the follicular, papillary and simple.

4 Nabothian follicles are formed when the process is undergoing an attempt to "heal."

5 Rest, local medication, plastic surgery and amputation of the cervix all have their indications in the treatment of the cervix.

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TREATMENT OF NON-UNION IN COMPOUND FRACTURES*

BY DE FOREST P WILLARD, M D
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THE treatment of non-union in fractures of the long bones has interested surgeons for many years. Since 1914 both our interest and our knowledge have greatly increased. At the present time there is still considerable controversy as to the proper methods of treatment. It would be impossible in any short paper to cover the various opinions that have been brought forward and it is my purpose only to give you some more or less related ideas on treatment of non-union following compound fractures due to war wounds. Although these cases differ from many that are seen in civil surgery, yet they closely resemble the type found in industrial surgery in that both show infection and marked destruction of bony and soft parts, combined with great functional loss. During the last half of the year 1917 I had the good fortune to be attached to the R A M C and to be stationed at the Military Orthopædic Hospital at Shepherd's Bush and at St Katharine's Hospital, London. At these hospitals were gathered the British war casualties that needed reconstructive work. Here were old cases dating back to the 1915 campaign on the Somme, as well as the fresh casualties of the Ypres and Passchendale battles. Here we saw the compound fractures in every stage of their treatment and of every sort—those that were healing by primary union, those showing delayed union, as well as the older non-union cases.

At both the hospitals it was our policy to classify a case as non-union only after every effort had been made to procure the results without surgical interference. And it may be mentioned in passing that many of the cases of delayed union, even those in which there was considerable separation of the fragments, united after prolonged fixation.

Many cases of non-union could have been prevented by better methods of fixation during the earlier stage of their treatment. Although I can give no definite figures, I feel convinced from the work that I saw first in England and later in France and in America, that the percentage of non-union in the casualties of the 1918 campaign was very much smaller than the cases injured in 1915 and 1916, and this is unquestionably due to the better surgical technic used at the C C S's, and especially to the use of Thomas splints, which gave such accurate alignment by fixation and extension and which were capable of being well applied by any of the enlisted personnel of the medical corps as well as by all medical officers. These two things, a skilful debridement with careful preservation of all possible fragments of attached periosteum and bone, and the accurate and

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TREATMENT OF NON-UNION IN COMPOUND FRACTURES

prolonged maintenance of proper alignment, were the main factors in the prevention of non-union

The cases of true non-union were due to infection or to extensive loss of bone substance caused either by the missile itself or by over-enthusiastic removal of bone fragments at the primary operation. The treatment of the cases divided itself into two distinct parts. First, the restoration of the function of the disabled limb, and, second, the treatment of the fracture. Both parts of the treatment are equally important, and I believe that we often neglect the rather monotonous and long-drawn-out functional restoration in our interest in the treatment of the fracture itself. An arm or a leg may be entirely useless from a false joint occurring in one of the long bones, but it may also be as much or even more disabled by the loss of a joint or muscle function that is usually found as a complication of the fracture. Good examples of this were the infected fractures of the arm. Finger motion and pronation and supination were almost invariably lost in these cases, even when the wounds were in the upper arm, and it was with the utmost difficulty that we obtained functional efficiency. Manipulation under an anæsthetic seemed to increase rather than decrease the disability. Prolonged treatment with splints that gradually forced motion combined with hot baths and massage gave us the best results. If this part of the treatment is delayed until after firm bony union is established, free motion of the joints distal to the fracture is almost impossible to obtain, and from the patient's standpoint his long stay in the hospital has been valueless because restoration of motion is the goal for which he was aiming.

Much of this disability can be avoided by early exercise—active whenever possible, passive only when the fracture is so low that active motion is prohibited. The good results of this early motion are well shown by the difference between the old cases of fractured humerus at Shepherd's Bush which had little or no attention paid to finger motion in the early stages of their treatment and similar cases which were treated at the Neully Hospital in Paris during the summer of 1918, and which had proper treatment started within a few days of their primary operation. At Shepherd's Bush 30 cases out of 40 showed marked loss of hand motion; while in France we had 100 consecutive cases of compound humerus fractures unite without loss of finger function.

During the pre-operative period in non-union cases, all systemic conditions which might interfere with union may be discovered and corrected, also the general nutrition of the injured limb can be greatly benefited by massage and hot bath treatment. In this period a short course of deep, heavy massage may be of great value in determining whether or not the scar tissue in the old infected areas is permanently healed. If a scar can withstand this heavy manipulation and can become less adherent and less red, it is safe to believe that operative procedures will not reawaken the infection.

In regard to the length of time that should elapse between the closing of all sinuses and the operation for non-union, there is still a great divergency of opinion. During our first contact with these cases we were told by our British colleagues that it was unsafe to operate for at least one year after the infection had healed. Naturally both the patient and surgeon were anxious to cut down this period as much as possible, and we finally adopted a procedure which we believed would give the best results. Usually we allowed six months to elapse before considering operation. If the primary infection had been mild and of short duration, this six-months interval can safely be shortened to four or five months. On the other hand, if the infection had been severe and prolonged, nine or even twelve months should elapse before operation is considered. At that time a ten-day course of heavy massage of the scar was carried out. If the scar showed no reaction, operation was done. At this operation the scar tissue was dissected away both from the soft parts and between the bone fragments. Smears were made from the deep tissues and the wound was closed. If the infection was reawakened as it was in a moderate percentage of cases, the wound was widely opened and the infection was controlled by Carrel-Dakin, so that the period of the patient's convalescence was not appreciably lengthened. If, however, the bacteriologic report was negative for virulent pathologic organisms, and if the wound remained closed, a second operation was done within eight or ten days. This second operation consisted of the actual repair of the fracture. For this no one procedure can be advocated. However, it can be said that the simpler the operation, the better the result. If the bone ends can be freshened and brought into apposition without disabling shortening and can be held there by the use of catgut or kangaroo tendon, it is better to stop without the use of more elaborate procedures. If this is insufficient we have a wide choice of various types of metallic or bone plates, of many kinds of bone graft, and of wire, screws, pegs, etc. In making a choice from these various materials, it should be remembered that the tissues of these patients have not the resistance that is normally found in cases in civil surgery. Both general and local vitality has been lowered by the long battle against infection, and these operative wounds must be handled much more considerately than those in normal healthy individuals. Personally, I object to all forms of metal, either wire or plates. They act as irritants and cause bone atrophy at the place where we want bone growth. There can be no doubt that bone plates cause atrophy. Any series of X-rays will prove it. While at Shepherd's Bush I removed or saw removed at least a dozen bone plates which had been inserted for non-union. Not one of the cases had united. Four of the plates were entirely covered in by abnormal callus and were found lying loose in a cavity of the bone just as we so often found sequestra. I can remember only one case that succeeded in uniting on account of—or, perhaps, in spite of—his bone plate. I can also remember two cases that

TREATMENT OF NON-UNION IN COMPOUND FRACTURES

were plated a year or more after their sinuses had closed, that became very septic after operation Both of these operations were performed by a surgeon whose technic was above suspicion Major Kinder states that on his service in England he did a series of over 20 bone plates, and that "careful investigation later revealed that over 60 per cent of these cases were complete failures either because active sepsis was stirred up or because the bones would not grow"

When some mechanical fixation is needed or when there is a bony gap to be bridged, the autogenous bone graft offers the best chances of success Theoretically, the sliding type of graft is the best, but practically the graft from another healthy bone, such as the tibia or rib, seems to be of greater service A graft to be successful must be snugly imbedded for a considerable distance in the healthy bone in both fragments It should reach to the medullary cavity, it should preserve both its periosteum and endosteum, and it should be of healthy non-sclerosed bone throughout its whole length It is hard to fulfill these conditions with a sliding graft Therefore, a graft from healthy bone seems preferable In the larger bones, as the tibia and femur, such large heavy types of graft work exceedingly well

In the smaller bones, such as the radius and ulna, the small thin graft does much better In the earlier parts of our war work we used a moderately heavy graft in these bones Healing proceeded normally, and at the end of four or five weeks the operation seemed very successful But at the end of the second or third month four out of my first five cases began to show thinning of the graft area, and this absorption continued until after the graft between the fragments had disappeared and the non-union had re-occurred Whether this was due to a very low grade infection, or whether the graft was so large as to interfere in the blood supply, I am unable to say I only know that the operations at the end of four months were failures I have had reports from other surgeons who have had similar results In subsequent cases, at the suggestion of Doctor Chutro, I have used a very thin, flexible graft, approximately $\frac{1}{8}$ of an inch thick, covered with plenty of periosteum, and laid sub-periosteally in a shallow channel dug in cortex of the bone ends Whenever possible this graft extended for two inches beyond the sclerosed portions of fractured bone ends The graft is held in place by suturing the periosteum of the bone over it This type of graft does not give good bony fixation, but this is hardly necessary in fractures of the lower arm It does give a bridge that stimulates bone repair more readily than does the larger type of graft I have been able to check up only a few of my own cases, but have succeeded in retaining bony union for periods of at least six or seven months From conversation with some of the British and French surgeons who were interested in this work, I feel sure that the thin, flexible type of graft in the smaller long bones is advocated by them

I have made no attempt to cover the whole subject of the treatment

DEFOREST P WILLARD

of non-union I have desired only to mention certain details of the treatment for your consideration and discussion, emphasizing especially, first, the need of early and efficient restoration of function of the whole disabled limb, second, the advantages of the two-stage method of operation on the old infected cases, and third, the usefulness of the Chutro type of graft in fractures of the smaller bones

DISLOCATION OF THE TARSAL SCAPHOID DOUBLE FRACTURE OF THE ISCHIATIC TUBEROSITIES *

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DISLOCATION OF THE TARSAL SCAPHOID

FRACTURE following violence is much more common than is dislocation of the bones of the foot This is a splendid illustration of the law of Colles who observed that when the tensile strength of bone and ligament was put to the test, the bone usually gave way first But despite the great strength of the ligaments which bind the component bones of the foot, dislocations of individual bones may and do take place, although fracture of these spongy bones occur much more frequently than do dislocations

Dislocation of the tarsal scaphoid alone is the rarest of all varieties of foot bone dislocations The security of position possessed by this bone is due to its anatomical relation with other bones, ligamentous, muscular and fascial supports plus the usual mechanical lines which force requisite in the production of these dislocations usually travels Although the navicular is not the true keystone of the anteroposterior arch of the foot, it is accurately buttressed by a semicircular facet over the head of the astragalus and firmly held in position by the dorsal, plantar and interosseous ligaments The tibials, peronei, flexor hallucis, flexor digiti and plantar fascia all lend additional support in maintaining this bone in position

The inferior calcaneo-scaphoid ligament is one of the chief anatomical factors in maintaining the arch by supporting the head of the astragalus through holding the scaphoid in place, the function of this ligament receives additional support from the tibialis posticus, the tendon of which splits into numerous fasciculi which are attached to most of the metatarsal bones The muscles concerned in supporting the articulations of the scaphoid are supplied by the anterior tibial nerve, hence injury to this nerve or impairment of function of the muscles supplied by it will favor destruction of the arch

Dislocation of the scaphoid alone may be regarded as a traumatic flat-foot, and we may perhaps gain a clearer insight into the pathology of this dislocation by a brief reference to the mechanism in the production of the deformity so frequently encountered, called flat-foot

Indeed, one very competent clinician has said that tarsal scaphoid dislocation never occurs in a foot possessing a natural arch In flat-foot we

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have eversion and abduction of the foot with loss of both the transverse and longitudinal arches in consequence of the unsupported head of the astragalus which is permitted to point downward

Owing to the lack of support from the articular surface of the scaphoid, the foot turns outward, increasing the inner side length of the foot and broadening its plantar surface. This condition is due to weakening of the tibialis anticus and posticus, the peroneus longus, and yielding of the internal, lateral, calcaneo-astragaloid ligaments and plantar fascia. This is essentially what occurs in scaphoid dislocations with this difference—one is of slow development and may be unaccompanied by pain, the other is sudden in origin, very painful, and has lacerated ligaments and the additional dorsal surface deformity incident to the misplaced scaphoid.

In a lax condition of the calcaneo-scaphoid ligament in the standing posture the weight is supported by the tibial muscles, and, although the ligaments limit the range of joint motion, the normal strain of weight bearing falls on the tibial group of muscles. The range of motion in the articular surface of the scaphoid under normal conditions is slight and limited to movement of the inner margin of the foot up and down, turning in and out of the toes has been erroneously attributed to mobility in this joint, but these motions are chiefly dependent upon the hip-joint for their accomplishment. From the intimate relation, with its anatomical surroundings, it becomes apparent that one of three routes is open for uncomplicated luxation of the scaphoid—dorsal, mesial and plantar. Outward dislocation of this bone would necessarily involve displacement of the cuboid and perhaps also the astragalus and calcaneus. Rupture of the interosseous ligaments and rupture or separation of the fibres of the calcaneo-scaphoid ligament must take place before the bone may be completely detached from its position in inward dislocations, and it is this separation of the fibres of the calcaneo-scaphoid ligament and the tendency on the part of the scaphoid to rotate on its horizontal or vertical axis which renders replacement of the bone difficult or impossible without open operation.

Failure to reduce luxation and the necessity of excising the bone has been encountered in the open operation in a number of instances.

Malgaigne refers to scaphoid dislocation as a middle tarsal dislocation and Sir Astley Cooper in his work on dislocations gives a very accurate picture of the deformity in his report of a case of luxation of the navicular bone.

Stimson, 1910 edition, records 5 cases forward on dorsum, 1 inward and forward, 1 inward, 2 downward and 1 outward on dorsum, 2 reduced without, 2 with operation, 3 unreduced, 1 excised, and 2 amputations for gangrene.

Speed, in 1916, "Fractures and Dislocations," collected the records of 43 cases of dislocation of the scaphoid, to this list he added the record of a personal case, making a total of 44 cases, which he classifies as follows



FIG 1 —Showing dislocation of scaphoid

Luxation of the naviculare cuneiform separations, 15, talo naviculare separations, 17, and total separation, 10; his own case added to the last class, making a total of 11 cases wherein the bone was wholly displaced from its normal moorings

The *Index Medicus* contains no record of scaphoid dislocation since 1916

CASE No 15333 —(Referred by Dr R H Whallon) Male, age 51 years, laborer, well developed, 5 ft 11 in, weight 180 lbs While hoisting a tank with an I-beam and chain, the chain slipped, causing the I-beam to be displaced, whereupon the beam and chain, the combined weight of which was estimated to be 600 to 700 pounds, fell, and in falling struck the patient a glancing blow on the left side of the head and chest, forcing the patient into a sitting posture with part of the apparatus resting on his left foot

When admitted to the hospital the foot and ankle were considerably swollen, the patient showed a mild degree of shock and complained of severe pain present in the left chest and ankle

Examination revealed, in addition to multiple bruises and abrasions, fracture of the seventh, eighth and ninth ribs on the left side and a protuberance on the inner side of the left foot in front of the head of the astragalus Crepitus was distinctly felt while examining the foot An attempt at reduction by the attending physician had partially reduced the deformity

The clinical diagnosis was fracture of the seventh, eighth and ninth ribs, dislocation of the tarsal scaphoid Fracture of one, undetermined, of the bones of the foot

X-ray examination at this time by Dr Lange confirmed the presence of a dislocated scaphoid (Fig 1), but failed to reveal a fracture The general appearance of the foot was that of an exaggerated flat-foot The head of the astragalus could be distinctly felt on the surface of the foot, the toes were directed outward, the outer side of the foot was turned upward

The protruding scaphoid was firmly fixed and could not be easily moved, neither would the hollow space recently occupied by the bone admit the tip of the examining finger although a sense of absence of bone at the plantar site could be detected The foot and ankle were steeped in hot saline solution for 24 hours, at which time the patient was etherized with a view to reducing the luxation The scaphoid could now be moved for a short distance in all directions, the outward direction of the toes and other deformities could also be increased by slight manipulation With the leg and thigh in a position of full flexion the heel of the injured foot was placed on the margin of the foot of the operating table and firmly fixed by an assistant A leather belt three quarters of an inch in width was thrown over the foot by a second assistant with a view to forming a fulcrum pressing against the displaced bone

Seizing the heel with the left hand and the toes with the right, the injured foot was forced into a position of extreme extension and while in this position the assistant made firm traction on both ends of the belt in an upward and outward direction The foot was now quickly placed in extreme flexion at which time the scaphoid slipped back into place with an audible thud When the foot was released and the belt pressure removed, partial dislocation followed which was easily corrected by pressure with the thumbs The foot was dressed in a position of semi-flexion and slight inversion, with a plaster-of-Paris case which extended well up to the knee

The dressing was continued for six weeks and the patient was permitted to get out of bed and on crutches at the end of ten days

Although the patient could not use the injured foot until after the reduction of the luxation had been accomplished, the functional result is very good, three months having elapsed since the receipt of injury

DOUBLE FRACTURE OF THE ISCHIATIC TUBEROSITIES

Viewed from an anatomical point the pelvis is the strongest bony cavity in the body. Force requisite in the production of fracture of the pelvic bones and continuance of the force after the bone gives way is relatively so frequent that extensive damage to the urethra, bladder, intestine and blood-vessels is the rule rather than the exception in this type of fracture. Search of the literature did not reveal the record of an uncomplicated case of fracture of the tuberosity of the ischium, although some of the textbook authors speak of the possibility of such fractures. Fracture of the tuberosity of the ischium is an unusual occurrence and might be said to be the most infrequent variety of pelvic fractures.

CASE RECORD No 13842—A farmer, aged 33 years, seen in consultation with Dr B K. Menefee. Was thrown to the ground from a wagon, landing squarely upon his buttocks, in which position he was dragged some distance. When admitted to the hospital the patient was suffering from a certain amount of shock and complained of an agonizing pain in the region of the anus. Under full anæsthesia the finger in the rectum encountered a hard mass in either ischiorectal fossa. The mass in the right fossa was easily moved by placing the opposing thumb of the examining hand over the site of the ischiatic tuberosity and making a lateral motion. This manipulation elicited crepitus.

The mass on the left side was larger, more firmly fixed and required more force in moving it, but this movement also elicited crepitus.

There was a considerable displacement of the fragments inward toward the rectum and upward toward the tip of the coccyx. So far as could be determined the rectal wall had escaped injury and the urine was free from blood.

It was concluded that there was present a double fracture of the ischiatic tuberosities. The fragments were replaced, in apparently complete alignment, by the same method which had been employed in examining the patient. A plaster-of-Paris spica was applied and retained for six weeks. Radiographic examination showed simple fracture of the right tuberosity but the fracture line on the left side, after separating the tuberosity, continued through the ramus and body of the bone into the wall of the acetabulum.

Complete functional recovery followed and there is no apparent deformity.

SUTURE OF WAR WOUNDS*

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MEDICAL SUPERVISOR, HARRISON WORKS, E I DUPOUX DE NEMOURS & CO, FORMERLY CAPTAIN, M C,
BASE HOSPITAL NO 4, ATTACHED TO D E F

I Organization—In dealing with war wounds it is necessary to remember that here the great problem is infection, and in combating this we are taking the biggest step forward in preparing the wound for suture. If it is borne in mind that war wounds differ from civil ones more in quantity than in quality, it will be easier to arrive at a safe and sane method of treatment. Hence, with the kind permission of the Deputy Director of Medical Services of Rouen, we established a hospital within a hospital for the care and treatment of cases suitable for suture. For this purpose, one ward was converted into a clean operating theatre, and one ward of forty-one beds and two tents of a total of sixty-two beds were turned over for the reception of suture cases. Patients with wounds of the legs and trunk were kept in the wards, and those with wounds of the head and upper extremities in the tents.

The cases that were admitted to this department were: (1) Those coming down the line marked D P S, *i e*, supposed suitable for delayed primary suture. (2) Those whom the ward surgeons thought suitable for suture with minimum of treatment. (3) Those sutured in the "old theatre," and sent for observation. (4) Those excised in the "old theatre," and in the judgment of the operator suitable for delayed suture, and (5) walking wounded whose convalescence excision and suture would shorten. The last, in my judgment, was the most important class (from the military standpoint) that we handled, and the class previously most neglected.

These patients (with the exception of the operative cases) were dressed by myself immediately, and appropriate treatment instituted. In the beginning each case had a colored tag (either yellow or purple) given him, and the pathologist making his rounds would culture every day the alternate color. Later on, as clinical judgment improved, all cultures were taken in the theatre just prior to operation.

Dressings were done instrumentally and with scrupulous attention to aseptic technic, each case being treated as if heavily infected, as, strictly speaking, many of them indeed were. Should a case become unsuitable for suture or a sutured case infected, such a one would be immediately

* The work in this paper was done between the dates of August 7 and October 27, 1918, at Base Hospital No 4, Rouen, France. I wish to express my appreciation to Dr. George W. Crile, for the opportunity to do this work, and for the helpful suggestions which he, from time to time, contributed during its course.

transferred Thus cross infection was avoided Temperature and pulse were taken on all cases three times a day

II *Types of Wounds*—For the sake of simplicity and adaptability for war use, wounds were classified for the purpose of suture into three groups, *viz* (1) Primary excision and suture (2) Delayed primary suture (3) Secondary suture or excision and suture

1 By wounds for primary excision and suture are meant those wounds which have had no previous surgical interference They will be suitable immediately or after appropriate treatment, for excision and closure

2 By D P S is meant that kind of case, operated upon at the Casualty Clearing Station (C C S), so carefully that it is, in the opinion and judgment of the operator, suitable for closure in one to three days He so marks it and evacuates it to the base

3 By secondary suture or excision and suture is meant all cases operated at C C S or Base that are suitable for closure in a few days or after epithelialization are suitable for excision and suture In fact, it includes all cases other than (1) and (2)

III *Preliminary Treatment*—I (a) Certain superficial and lacerated wounds in the absence of fever or local inflammation are treated by immediate excision and suture The results are good

(b) Where there is a local inflammatory reaction of mild degree, shown by a dusky red epithelial edge, it has been deemed advisable to treat the wound with methyl alcohol twice a day until charring or dryness of the wound is present (though one could probably get a good result by wide excision, yet it is highly desirable to save as much skin as possible) The charred brown crust is a good guide (in operating) to the extent of dead tissue present It is a well-established fact that a dry wound does better than a moist one

(c) Certain wounds with acute inflammatory reaction and fever are treated with hot dressings (or fomentations) consisting of gauze and lint wrung out in boiling water and applied at the maximum temperature that the patient will stand The part is then wrapped in jaconet The dressings should extend wide of the wound When the temperature falls and inflammation and discharge decrease, methyl alcohol is used to dry up the wound This process of applying hot dressings is done every four hours, and is necessarily time consuming In rush periods it has been found advisable to use hot dressings during the day and to apply an alcohol dressing at night, to be removed in the morning when hot dressings are resumed The combination is a good one and diminishes the maceration of skin surfaces Hot dressings should be discontinued as soon as possible

By these methods the average wound should be ready for excision and suture in from three to five days Cases that did not improve were relegated to class 2 for treatment

2 Treatment here should be the minimum If fever and any consid-

erable amount of discharge is absent, packing and dressing next to the wound are not disturbed. If for any reason packing is removed, it is well to apply hot dressings for one day to develop a local reaction and re-establish defense. A local leucocytosis is produced, which bars the spread of infection and tends greatly to control the infection already there. This may be useful prior to excision for the same reason.

I find it preferable to use dry dressings where possible. Where inflammation and fever are present they are treated by the usual means. Where fractures are present, hot dressings are indicated up to time of operation.

The question arises—How much of the wound should be excised at the front?

If after-results are to be considered, only the obviously dead tissue should be removed. The more carefully the dead tissue is removed and the more thoroughly all recesses are explored, the better are the results. As much skin as possible should be preserved, so that subsequent delayed primary suture can be done.

And again, should all loose pieces of bone be removed from compound fractures at the front? Probably not. Those pieces that are detached or obviously infected must come out. Adequate drainage is the main consideration. It were better to leave in numerous pieces with adequate drainage than one piece without it.

Another point to be decided is the best treatment to be started on débrided wounds at the front, and carried out until the patient reaches the base in order to give the best results insofar as early suture of the wound is concerned. Flavine gauze seems to have been the most popular and to have given the best results. Flavine is a mild antiseptic and the patients on whom it is used travel comfortably, and arrive at the base with red healthy wounds. After infection is established flavine is *useless*.

Paraffine gauze has given satisfactory looking wounds also.

Carrel's irrigation as a travelling treatment has been a disappointment, and the wounds reaching the base that have been so treated are the most hopeless, nasty, soggy messes that can be described. Carrel's cases should not be moved until the work of wound disinfection has been accomplished. On the ambulance train the irrigation is irregular, tubes pull out and the dressings become a moist warm culture tube.

Where B I P has been used, results are fairly good.

3 These cases are treated according to indications outlined above.

IV *When is a Wound Suitable for Suture?*—In my experience, three days after operation is the ideal time for delayed primary suture, since prior to this time tissue resistance is not sufficiently established, and after that time infection is apt to occur.

A red, slightly moist wound that bleeds slightly when the dressing is removed, is ideal for suture.

Contraindications are 1 Inflammatory reactions 2 Serous discharge

3 Malodor 4 Fever 5 Tension when coapted 6 Multiple wounds on a very sick patient 7 Anatomical inability

V *Anæsthetic*—The anæsthetics used most frequently were $N_2O + O_2$ and ether Primary chloroform was used in thirteen cases for primary excision and suture Local anæsthesia was used when wounds were small and time not pressing $N_2O + O_2$, or local with novocaine are to be preferred where practicable, since the patients, as a rule, suffer little pain and require little time for the operation, and where $N_2O + O_2$ is used it is easy for a surgeon to keep three or four tables running continuously

VI *Scrub-up*—The skin is scrubbed with soap and water, shaved, washed with sodium bicarbonate solution, ether and alcohol, and painted with iodine If packing is present, it is left *in situ* up to this point Then it is removed and a culture of the wound taken

VI-a The clean suture theatre was equipped with a small sterilizer, 5 operating tables, and 4 "set-up" tables For each table there was a small wire net tray with handles In each tray were placed 4 Halsted hæmostats, 2 Ochsner straight forceps, 2 Parker knife handles, 2 blades for same, 1 pair surgical scissors curved on the flat, 1 full curve and 2 half curve large surgical needles, 1 or 2 thumb forceps, 1 needle holder (Crile), 1 small roll fine silk, 12 sutures of silk-worm gut, medium On the table were 1 tube of o catgut, sponges, dressings, 2 or 3 towels and small bowls of iodine and methyl alcohol After each new case was finished, the tray was removed and re-sterilized, but the table did not need to be touched

From the beams there were small rubber loops used for suspending arm or leg

Operate on the stretchers, if necessary

VII *Operative Technic*—In classifying operative wounds for sake of simplicity they are divided into First degree or involvement of skin and subcutaneous tissue Second degree or involvement of soft parts Third degree or involvement of bone

1 In the smaller wounds for primary excision and suture, prepared by hot dressings and alcohol, an elliptical incision is made, saving as much skin as possible, but going outside of any skin redness, removing the desiccated surface *en bloc*—the knife at no place touching the wound Unnecessary sponging is avoided, fingers are kept *out of* the wound, hemorrhage is controlled by the sutures and pressure

Sutures are, if possible, passed entirely under the wound surface, and, before the last stitch is tied, firm pressure is put on to remove the blood An alcohol dressing is applied The palm of the hand then exerts pressure on the wound for five minutes and the outer dressings are applied

2 In deeper wounds, as little tissue as possible is removed in order not to open up new channels for infection Fascial tags and small areas of necrosis are excised These wounds have been closed as late as the sixth day without excising the epithelial edge In these wounds, three objectives, and only three, were considered vital, namely the obliteration

tion of all dead space, coaptation with the least-possible tension, and as little use of ties and buried sutures as possible, for it was observed that many of the cases coming down the line showed areas of necrosis at the site of the ligatures around vessels

Alcohol, Dichloramine-T and iodine have been put into the wound prior to suture, but results have been no better than if no antiseptic was used. Dead space is obliterated by tension sutures rather than by buried sutures of catgut. Where this is impossible drain by silk-worm gut or B I P and close loosely. Alcohol or dry dressings are applied. Deep bite on the skin edge is taken.

If there is bone injury in any one of these classes, the bone ends are freely exposed, clots in the shaft removed, and the ends cleansed and bipped. Immobilization by splint, posture or both are rigidly adhered to.

3 Antiseptics are of more value here, and handling and operative technic should be reduced to a minimum. Many compound fractures were successfully converted into simple fractures by this method.

VIII Post-operative Treatment—In the absence of fever, the dressing is not removed until the fourth day after operation. Fever the night following operation is usually reaction and means little. Fever the next morning is more significant and almost invariably denotes infection. At this stage, hot dressings continued for a day or two will usually clear up incipient infection without the sutures having to be removed. When infection is established around a suture, the sooner the stitch is removed the better. A stitch in time saves nine!

On the fourth day after operation, another alcohol dressing is applied. The wound is not touched again until the day the sutures are to be removed, which for the face and scalp is two to three days, the shoulder, buttocks, thigh, calf, nine days, other areas from seven to eight days. It is well in larger wounds to remove part of the stitches on one day, the remainder on the tenth day.

If infection is going to occur, it will usually appear on the second or third day, though occasionally as late as the sixth day. The larger wounds may have hot dressings for several days following operation. Posture and splinting are valuable. Sutures have been removed for P U O, mistaking the fever for that of infection.

IX Results are classified as

(a) Success—where the object sought is obtained, whether that be a complete or partial suture.

(b) Partial success—where less than half of the sutures show stitch abscesses, or where separation of part of the wound occurs.

(c) Failure—infection of more than half of the sutures.

X Failure or partial failure has been dependent upon the following factors: (1) Failure to obliterate dead space. (2) Tension on the sutures. (3) Both. (4) Incomplete excision. (5) Presence of infected wound in vicinity.

DRURY HINTON

TABLE I
(Results All Under Battle Conditions)

Total 270	{	S	228	84 43%
		PS	32	11 87%
		F	10	4 7%
Of 228 S	{	I	54	23 68%
		II	135	59 22%
		III	39	17 10%
Of 32 PS	{	I	7	21 87%
		II	16	50 00%
		III	9	28 13%
Of 10 F	{	I	1	10%
		II	6	60%
		III	3	30%
Of 62 I	{	S	54	87 1%
		PS	7	11 3%
		F	1	1 6%
Of 157 II	{	S	134	85 4%
		PS	17	10 8%
		F	6	3 8%
Of 51 III	{	S	39	76 5%
		PS	9	17 6%
		F	3	5 9%

It can be seen from Table I that wounds of the skin and subcutaneous tissue are closed more successfully than those involving muscle. Wounds involving bone did least well. Only 30 per cent of the failures were in bone injuries, but these three were in a total of 51 or 59 per cent of all bone wounds, whereas the 60 per cent of the failures that occurred in muscle injuries were only 6 out of a total of 157, or 3 6 per cent. There was 1 failure to every 62 wounds of skin, to every 26 wounds of soft parts, and to every 17 wounds of bone.

TABLE II
(Results All Under Battle Conditions)

Excision and sutures	112	{	S	98	87 5%	
			PS	10	8 9%	
			F	4	3 6%	
Delayed primary suture	124	{	S	106	85 5%	(30 unsuitable, 24 evacuated)
			PS	15	12 1%	
			F	3	2 4%	
Secondary	34	{	S	24	70 6%	
			PS	7	20 6%	
			F	3	8 8%	

SUTURE OF WAR WOUNDS

In Table II is shown the difference in results obtained in primary excision and suture, delayed primary suture, and secondary excision and suture

TABLE III
(Results All Under Battle Conditions)

Suture Theatre	208	S	178	85.6%
		PS	23	11.0%
		F	7	3.4%
Old Theatre	62	S	50	80.7%
		PS	9	14.5%
		F	3	4.8%

In Table III are compared the results secured in the Suture Theatre where everything was under control and in the old theatre which received septic as well as clean cases. Though the number of cases is small in the second group, yet the effect is evident.

TABLE IV
(Results All Under Battle Conditions)

Amputation	S	P S	F
Forearm	4	0	0
Arms	1	0	0
Legs	1	0	0
Syme's	1	0	0
Thigh	0	0	1

In Table IV are the results of amputations sutured by delayed primary suture. The failure resulted in leaving the knee bursa in the flap.

Discussion—These patients with wounds of lower extremities and trunk have been kept in bed until the stitches have been removed. It cannot be too much emphasized that wounds around the shoulder and scapular region do not do as well on ambulatory as on lying patients.

Does excision and suture save wastage of man-power? In the experience gained from twenty-three months' observation of walking patients it has been apparent that the most trivial appearing wounds have often taken several weeks to heal. Particularly is this so over bones close to the surface, for example, shin, joints, and active muscle parts. Excision and suture has sent these men to convalescence camp in ten days, and there were times in March and April, 1918, when every man counted.

Other results obtained have been (1) Shortened convalescence (2) Saving of hospital space, especially ward space (3) Saving of dressing materials (4) Lessening of disability by closing the gap to be filled in by scar tissue (5) Cosmetic

Wounds should not be closed unless they can be continuously under the care of the operating surgeon until the wounds are healed. If it is necessary to move a sutured case before completely healed, he should be

evacuated at once and not on the third or fourth day when infection may be spreading

In the case of knee-joints and tendon sutures, it is wise to leave the skin open at the first closure operation and to close on the third or fourth day

Leaving in untied sutures to be closed subsequently is a bad procedure. They may become infected and delay closure. They are foreign bodies and a handicap

Clinical judgment is sufficient to close a wound

It is better to close a portion of the wound or to close the whole wound and have part or even half of it break down, than to do nothing. Though theoretically you may fail, yet actually you have lessened the amount of surface that is absorbing toxins. Should the whole wound break down you have done the patient, as a rule, no harm other than a few days' delay. In some knee cases and huge wounds of back and thigh with wide gaping muscles and loss of much skin, where anatomically closure has seemed impossible, by three or four partial closures at three or four day intervals, the wounds have been entirely approximated

Many of the wounded objected to having their wounds closed, inasmuch as they were returned to duty sooner, and missed their sick leave. This difficulty was overcome by granting the men a short leave home, and it was surprising the way in which apparent disabilities disappeared

The average stay in hospital was ten to fourteen days

XI *Bacteriology*—Cultures were taken in the theatre prior to operation and 75 per cent of the wounds contained bacteria. Clinical judgment alone was relied upon in selection of cases for suture. Hæmolytic streptococci appeared in no sutured wound

TABLE V		
Total, 135	{ Negative	34 or 25%
	{ Positive	101 or 75%
Of 101 positive	{ Staphylococcus	42
	{ Streptococcus	9
	{ Gram — Bac	8
	{ Gram + Bac	9
	{ Anaërobic gas formers	7
	{ Multiple without gas	10
	{ Multiple with gas	16
		<hr/>
		101
Tetanus Bac		1

Wounds clinically but not bacteriologically clean did well after suture. Were Carrel's dictum strictly followed out less than 50 per cent of these cases would have been suturable

Most of the failures occurred where the Gram-Bac (pyocyaneus) appeared. One failure occurred with a negative culture

SUTURE OF WAR WOUNDS

XII *Fractures*

TABLE VI

	S	P S	F
Radius	9	0	0
Femur	2	0	0
Radius and ulna	2	0	0
Fibula	1	0	0
Sternum	1	0	0
Tibia and fibula	1	0	0
Spine	1	0	0
Tibia	4	1	0
Scapula	3	1	0
Humerus	4	5	0
Skull	3	0	1
Carpus	1	0	1
Totals—			
S			32
P S			7
F			2
			—
			41

Nearly all these were delayed primary sutures or primary suture. Where the fractures were recognized, hot dressings and appropriate splints were applied, and kept on until time of operation. Femora and humeri were operated upon in the splint where possible.

In this series, at least, the Heitz-Boyer modification of the Leriche technic was followed. The medullary cavity was not touched until all other parts of the wound were thoroughly explored and cleaned up. Then the cavity was curetted for a distance of 1 cm. above the highest crack in the bone after dependent drainage in the bone had been obtained. Usually B I P was rubbed lightly into the raw bone surfaces and a slight streak from the bone to the dependent part of the wound to act as a capillary drain. The wound was then loosely closed, hot dressing applied and splinted. Where impossible to close directly two lateral relaxation incisions were made, the bone closed over and the two wounds of the soft parts treated by delayed primary suture or secondary closure. In this way, the incidence of osteomyelitis was reduced. (Dichloramine-T did not seem to be as useful in this type of wound as in others. It blackened the bone and detached periosteum.) Hot dressings were continued for several days and then replaced by alcohol. These patients were not evacuated so soon as other types.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting, held November 12, 1919

The President, DR WILLIAM A DOWNES, in the Chair

RECURRENT INTRAMEDULLARY OSTEIODCHONDROMA OF FEMUR

DR DEWITT STETTEN presented a patient thirty-two years of age, who had first come under his care nearly nine and a half years ago. There was no history of syphilis or trauma, but there had been an old apical tuberculosis. For six months he had complained of pain in his left hip and a bad limp. This had begun suddenly and had gradually progressed. He had lost 5 pounds in weight. A tuberculous coxitis in its incipient stage was suspected.

On June 28, 1910, while in the country, he had a slight fall, after which he was unable to walk. He was treated for a fracture of the left femur, possibly complicating a tuberculous focus. He was admitted to the Lenox Hill Hospital July 5, 1910. There was 15 cm shortening of the left leg, but no eversion. Active motion at the hip was impossible. The X-ray showed a rarefied area in the upper extremity of the femur. It involved the great trochanter and extended toward the neck and came down the shaft for a distance of about 10 cm. There was a fissure in the upper surface of the neck and a slight coxa vara. There was no expansion of the cortex. A cyst was suspected and conservative treatment adopted for the time being. A plaster cast was applied for a week and then a Buck's extension for four weeks. A few days after the removal of the extension, the patient, while moving in bed, felt something give way, and had severe pain in the upper part of the thigh. Examination showed a marked outward bowing of the upper part of the femur with 12 cm shortening. The X-ray showed a decided increase in the degree of rarefaction, still without cortical expansion, though part of the outer cortex had practically disappeared. There was a transverse fracture at the lower pole of the rarefied area. Extension was at once reapplied and operation for what still appeared to be merely a bone cyst decided upon.

The operation was performed on August 25, 1910. Through a longitudinal incision on the outer side of the thigh, the upper part of the shaft of the femur was exposed. The cortex was entirely gone. Instead of entering a cyst, however, a very hard, solid tumor was encountered. This was enucleated subperiosteally without much difficulty. It was

irregularly lobulated, with an indistinct fibrous capsule, and measured approximately 10 cm in length, 5 cm in width, and 5 cm in thickness. The cavity was thoroughly curetted. Except for a spur of bone, with the lesser trochanter attached, running down from the neck, the upper extremity of the femoral shaft was completely destroyed. The wound was packed, and extension applied.

On section the tumor presents a smooth, hard, homogeneous surface. Microscopic examination shows it to consist mainly of small, irregularly disposed spindle-cells imbedded in a hyalin ground substance. This appears to be undifferentiated osteoid or chondroid tissue. Scattered throughout the growth are islands of true cartilage of varying size. In places these cartilaginous islands are undergoing ossification.

Regeneration was rapid. There was good union in eight weeks. The extension was removed in two months, shortly after which the patient was allowed up with a Thomas splint to guard against refracture. The wound healed in about four months. There was less than 1 cm shortening, practically no coxa vara, and no eversion. The movements of the hip-joint were perfectly free. Within four and one-half months after operation the patient was walking without crutches. Radiographic examination six months after operation showed marked obliteration of the defect in the bone, even to the beginning replacement of the great trochanter, with practically no deformity. He was then given a course of X-ray treatments. Later radiographs show almost complete restoration of the bone with a preservation of normal contour which reached its maximum perfection in about two and one-half years.

For six years the patient had no trouble with his leg. He gained weight, walked with practically no limp and was apparently well. In September, 1916, he again complained of pain in his left hip and he developed a decided limp. X-ray examination revealed an increased irregularity of the contour of the upper part of the shaft of the femur and great trochanter, with marked mottling of the shadow due to irregular areas of rarefaction. This condition extended into the neck and seemed to extend 2 to 3 cm further down the shaft than before. A recurrence was suspected and repeated radiographic examinations made. Within two months the areas of rarefaction had become more definite and just below the great trochanter the cortex had been eroded. A decided outward bowing at the lower level of the disease developed. The extension up into the neck and down into the shaft had also increased. The diagnosis of the recurrence was now definitely established and reoperation determined upon.

On November 24, 1916, a second operation was performed. The old scar was excised and the upper end of the femur was exposed. The bone was riddled with tumor tissue of the same consistency as the original tumor. This was imbedded in an irregular bony network. The diseased

tissue was thoroughly removed piecemeal with a curette. Compared to the easy enucleation of the primary tumor, the difficulty of this procedure was very noticeable. In places the neoplasm had broken through the cortex into the soft parts. The removal of the disease left a defect even greater than after the former operation. The neck and upper part of the shaft were fractured, leaving a small fragment between the fractures. The wound was packed and extension applied.

The microscopic examination of the tumor tissue shows it to be practically the same as the primary growth, except that in places spicules of true bone appear. In the neighborhood of these bony islands the tumor parenchyma merges with the periosteum and osteoblastic tissue, without previous cartilage formation. The tumor cells are here more crowded, suggesting the character of a spindle-celled sarcoma.

The defect gradually filled in. The extension was removed in one month, but several weeks later was reapplied because of outward bowing at the site of the fracture of neck, and inward bowing at the fracture of the shaft, especially the former. In three weeks the extension was again removed. Two months after operation the patient was allowed up, and shortly after that went home, with what appeared to be firm union, particularly at the fracture of the shaft. There was scarcely 1 cm shortening. Within a week he returned to the hospital with a marked coxa vara, the fracture at the neck having again given way. Extension was immediately reapplied, and the deformity promptly corrected. When the extension was removed after two months more, there was good union and practically no shortening or other deformity. The wound closed in about four months.

The patient remained well until July, 1917, when he slipped and again fractured the neck nearer the head. It was not complete, but it produced the usual coxa vara deformity. Unfortunately, he objected to going back to the hospital and it was not possible to give him satisfactory treatment at his home. He was kept in bed eight weeks with an improvised extension for six weeks, but the deformity was never fully corrected. Union, however, was good, but there was a marked coxa vara with 4.5 cm shortening. He had no further trouble until January 30, 1918, when he fell again and sustained an irregular transverse fissure through the shaft, just above the point of union between the shaft and the intermediary fragment left after the second operation. He was treated by extension and kept eight weeks on his back. A good callus soon formed, but the shortening was a trifle increased by a slight inward bowing at this point. Since then he has no difficulty. The last X-ray taken in January, 1919, shows a dense bone formation in the upper part of the femur with the remains of the callus at the site of the last fracture. There is a marked coxa vara deformity, but no sign of further recurrence. The patient has a slight limp, but he has no pain and can easily sustain his weight on the



FIG 1 —August 22, 1910 Radiograph immediately prior to first operation Note marked increase in the degree of rarefaction absence of part of the outer cortex though still without expansion, and transverse fracture at lower pole of rarefied area

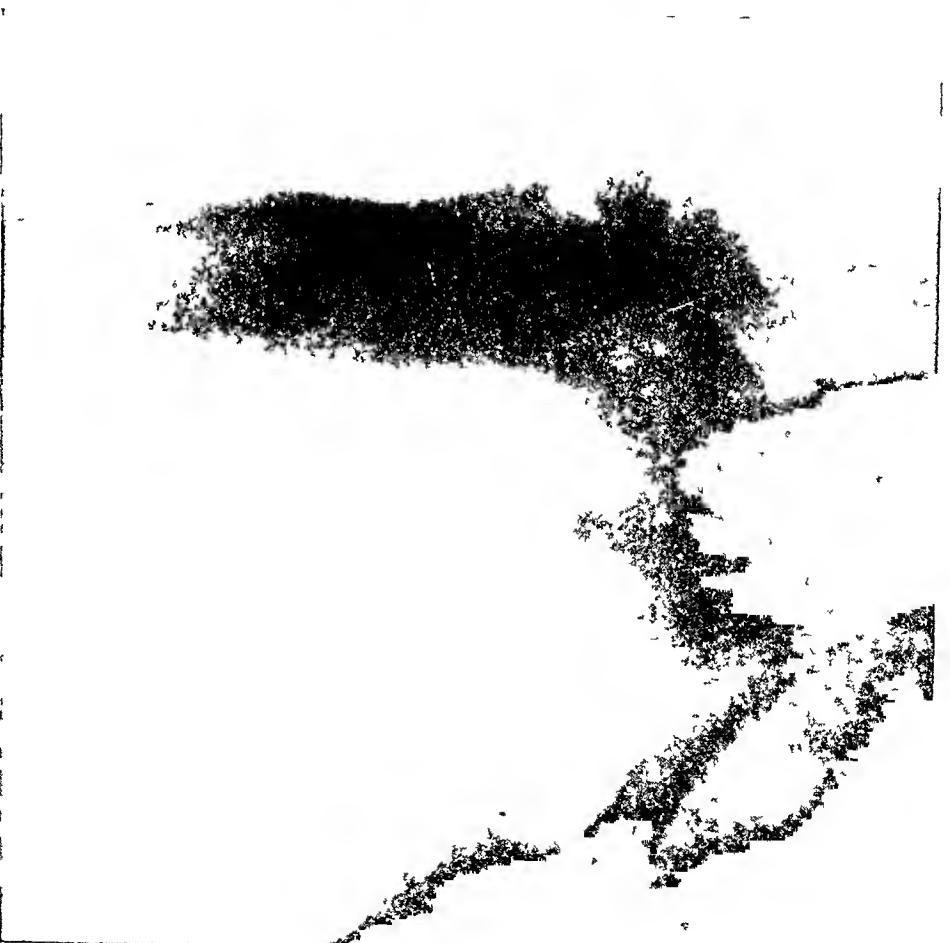


FIG 2 —March 9, 1913 Radiograph two and one half years after first operation Shows almost complete obliteration of defect by replacement with dense bone and preservation of practically the normal contour There is no evidence of recurrence



FIG 3 —November 21 1916 Radiograph six and one fourth years after first operation shows marked increase in definiteness and size of areas of rarefaction with further extension up into neck and down shaft There is extensive erosion of the outer cortex below great trochanter and a decided increase in the outward bowing at the lower pole of the lesion Diagnosis of recurrence definitely established

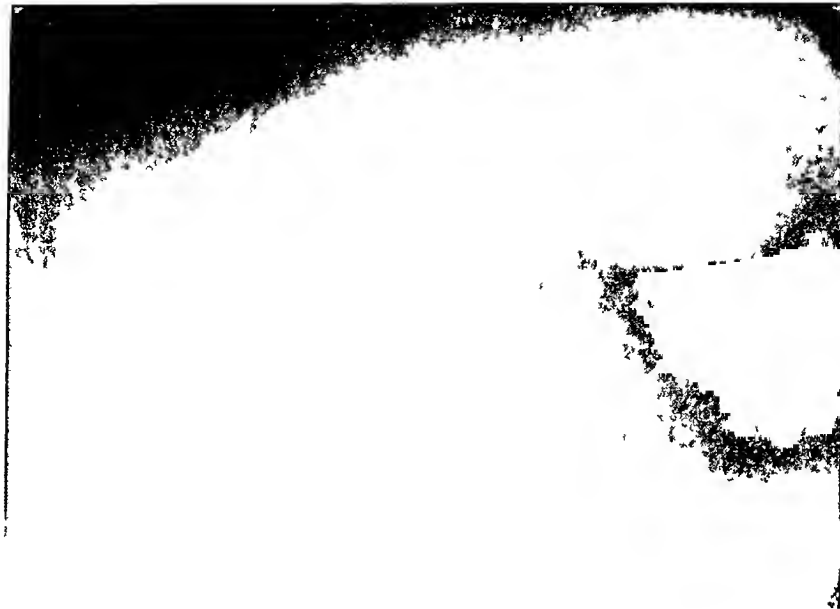


FIG 4 —April 2 1917 Radiograph four and one half months after second operation The coxa vara deformity due to refracture of neck has been entirely corrected There is evidence of further callus formation at the site of fracture Compare with FIG 16

Fig 5—January 11 1910. Final radiograph eight and one half years after first and about two years and two months after second operation. Dense bone replacing operative defects with remains of callus at site of last fracture. Marked coxa vara. No trace of recurrence.

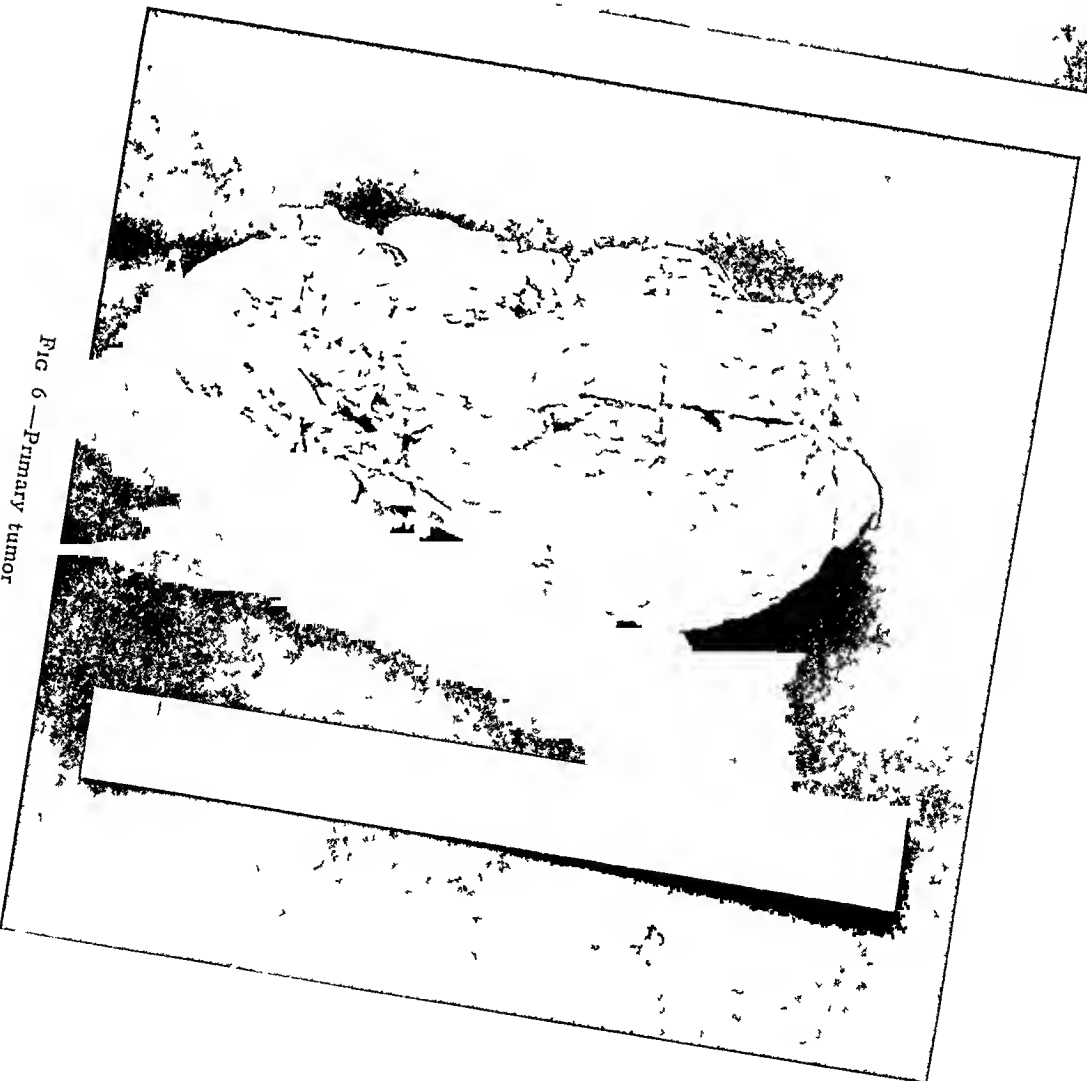
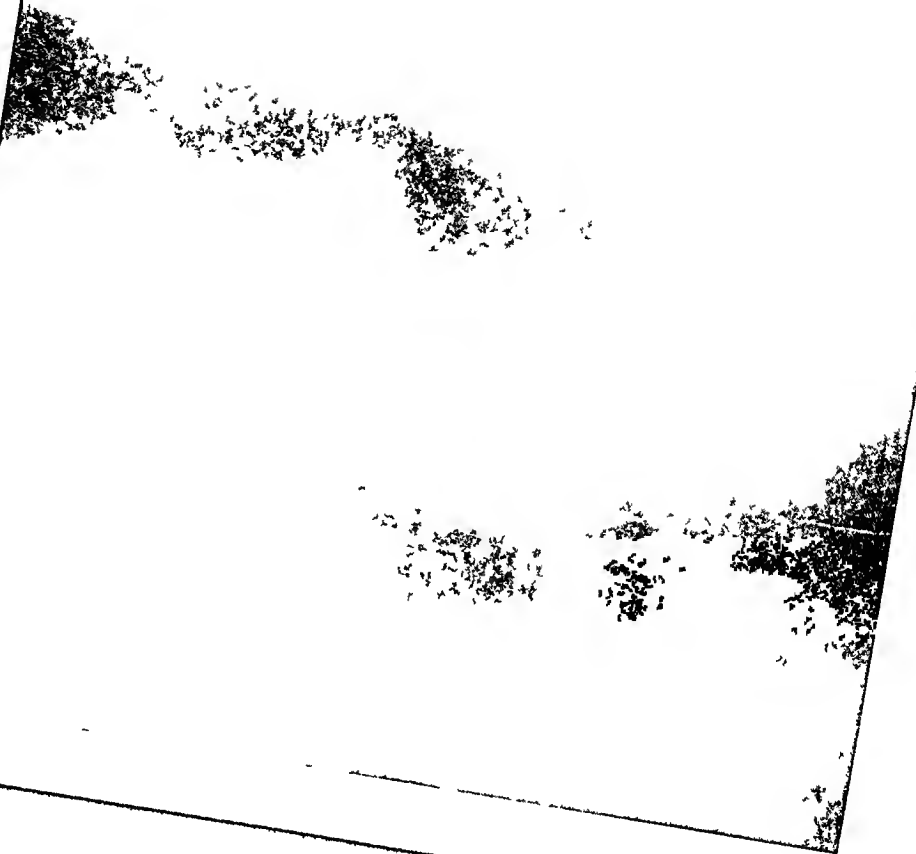


Fig 6—Primary tumor



FIG 7 —Microphotograph from primary tumor. Note cartilaginous island in undifferentiated cellular tissue with osteogenesis in the cartilage. Magnified 50 diameters.

REFRACTURED FEMUR WITH PLATING

affected leg There is 5 cm shortening without eversion The movements in the hip-joint are practically normal He has gained 30 pounds in weight and is apparently perfectly well

According to Bloodgood, these central cartilaginous tumors are extremely rare In a paper in the ANNALS OF SURGERY, August, 1910, he mentions an analogous case of Le Conte's, which he speaks of as unique up to that time The name osteoidchondroma has been applied by Borst to this type of tumor, who classes them among the less benign chondromata

REFRACTURED FEMUR WITH PLATING

DR FORBES HAWKES presented a boy sixteen years of age On August 1, 1914, while playing in the street he had been struck by an automobile and had sustained a fracture of the left femur about its middle He had been taken to his home where his physician had applied extension in bed for about six weeks On getting up and around a shortening of about 2 inches had been noticed His mother insisted that something be done to correct this shortening

He was brought to the Presbyterian Hospital where he was first seen by Doctor Hawkes on November 1, 1914 A shortening of about 2 inches was found in the left extremity with outward rotation of the limb below the fracture The X-ray showed a united fracture of the left femur with angulation

Open operation was performed on November 9, 1914 Solid bony union was found between the angulated and overlapping fragments The union was broken with chisel and the upper fragment inserted into a V hollowed out in the lower fragment A vanadium steel plate was attached with screws During the manipulations a small piece of the lower fragment of the femur had broken off and this was attached to the shaft with a circular piece of wire A plaster-of-Paris case was applied The wound healed without suppuration Measurements showed a scant $\frac{1}{8}$ inch shortening The callus was very slow in forming and it was not until October, 1915 (eleven months after his operation), that he was able to discard all support with good use of the limb The knee was stiff from long continued immobilization

On January 8, 1916, he made a false step while playing out of doors and he felt something "crunch" at the site of the old fracture He was again taken to the Presbyterian Hospital where two inches of shortening were found and the X-ray showed a refracture through the old area with angulation and the steel plate loosened Extension was applied for about four weeks in bed with increasing weights, but the shortening could not be reduced to less than $\frac{3}{4}$ inch It was then decided to remove the loosened plate and to readjust the fractured ends At the operation on February 3, 1916, no union was found between the upper and lower

fragments The small piece of bone which was broken during the first operation was, however, found to be solidly united to the lower fragment The old plate was removed with the portion of wire, and a smaller vanadium steel plate attached with screws, after the ends of the bone had been brought into good apposition and alignment He was put up again in a plaster-of-Paris splint Primary union of the wound was obtained

On removing the case, March 29, 1916, some outward angulation was found and there was $\frac{1}{2}$ inch shortening This angulation was rectified by manipulation under gas anæsthesia on March 30, 1916, and Buck's extension applied The X-ray then taken showed a straighter limb, fair apposition of the fragments, some of the screws loose, and an increase in the amount of callus This callus was again slow to form and extension was kept up until about November 1, 1916 By January, 1917, he had a good callus and the measurements on both sides were alike He was gotten up on crutches and by the middle of the summer was getting around on the limb with the help of a cane which he was unwilling to discard The stiff knee was gradually yielding to baking and massage

On September 22, 1918, he slipped and fell head over heels down an embankment striking his head and left thigh He was taken to the Lawrence Hospital first, where they diagnosed a fracture of the left femur, and the next day to the Presbyterian Hospital again The X-ray there taken showed a transverse fracture of the left femur above the site of the old fractures and just above the insertion of the upper screw of the last plate—with some lateral tilting of the fragments He was put up in extension for about eight weeks, the weights being gradually increased Callus formed fairly rapidly and by December 4, 1918, he was up and around on crutches with solid union and no shortening or possibly a scant $\frac{1}{8}$ inch, and 15 degrees of flexion in the left knee He then gradually got around with a cane and except for the muscular atrophy due to the repeated immobilizations and to diminished flexion of the knee he had good use of the limb

During the summer of 1919 he had signs of plate irritation and his mother wished the plate removed The plate and screws were removed on August 29, 1919 Perfectly solid union was found at the site of both fractures The wound healed by primary union and the boy has good use of the limb at the present time

DR HOWARD LILIENTHAL called attention to the disadvantage of leaving Lane's plates in for any length of time, advocating their early removal and stating that for this purpose he employs special screws and the removal of the plates at the end of three weeks, at which time it is possible to accomplish their removal without an anæsthetic and without pain Healing then proceeds as in an ordinary fracture, sound union being the rule

CHOLECYSTOGASTROSTOMY FOR COMMON DUCT OBSTRUCTION

CHOLECYSTOGASTROSTOMY FOR COMMON DUCT OBSTRUCTION

DR WILLIAM A DOWNES presented a patient, aged fifty-eight, admitted to St Luke's Hospital July 2, 1918. For past six weeks has had pain in the epigastrium radiating to both right and left sides. This pain came on suddenly, increased by food, relieved by vomiting. For the past five days had constant nausea—unable to retain anything on stomach, vomitus dark in color. One week ago noticed jaundice. Lost 30 pounds in weight since onset of symptoms.

Examination showed a fairly well-nourished man, slightly jaundiced. No masses in abdomen and no tenderness. X-ray examination negative.

Operation (July 8, 1918) —Gall-bladder was distended but contained no stones. No stones in common duct. Pancreas enlarged and stony hard from head to tail. Gall-bladder was freely movable, and easily anastomosed to the anterior surface of the stomach. Stab wound drain in the right flank—wound closed. Convalescence uneventful. Discharged August 7, 1918. Patient has continued to gain in health and is free from all symptoms at the present time.

A second case, aged forty-eight years, was admitted to the Medical Service, St Luke's Hospital, August 6, 1919. Two months before admission patient began to feel weak and lost his appetite. Five weeks ago had an attack of vomiting. Three similar attacks subsequently. Has had no pain or feeling of discomfort in the epigastrium. Two weeks before admission to hospital had a chill and this was followed by jaundice. Soon noticed that bowel movements were clay-colored.

Examination showed well-marked jaundice, otherwise negative except for slight tenderness in gall-bladder region. Under medical treatment jaundice gradually disappeared and patient was discharged on August 30 with a diagnosis of catarrhal jaundice, possibly cholelithiasis.

Readmitted October 3, 1919, with marked jaundice and with a history of having had repeated chills during the past two or three weeks. Temperature on admission, 104°. Slight tenderness in region of gall-bladder, but no definite mass could be made out. Patient had lost 30 pounds since the onset of symptoms. Probable diagnosis was common duct stone, possibly neoplasm.

Operation (August 6, 1919) —Cholecystogastrostomy. Gall-bladder was found to be moderately distended and common duct also distended. Exploration of gall-bladder and duct showed no stones. Head of pancreas was enlarged, hard, and seemed to be the seat of a new growth. Gall-bladder was easily sutured to anterior wall of the stomach. Culture from gall-bladder showed colon bacillus. Wound closed without drainage. Convalescence uneventful. Discharged November 5, 1919. Jaundice rapidly disappearing, patient is gaining and is relieved of all symptoms.

DR HOWARD LILIENTHAL inquired why Doctor Downes chose the

stomach for his anastomosis. He had performed the operation of cholecystenterostomy in suspected carcinoma of the pancreas. He also was not willing to grant from the presentation of the second case that the patient was not suffering from carcinoma of the pancreas.

DR EDWIN BEER considered these cases very instructive and interesting. He stated that as Doctor Downes had intimated, there was a tendency in obstructive jaundice where no stones are found, but where there is more or less induration and tumefaction of the head of the pancreas, to close the abdomen without a side-tracking operation. He considers this practice a vicious one because in such cases, at times, excellent results can be obtained by side tracking the flow of bile either into the stomach or intestine. With regard to the reported cases he considers no one can say definitely whether they were malignant or not. In undoubtedly malignant cases where there is a palpable nodular tumor in the head of the pancreas, it is good practice to side track if the patient's condition will allow it, there is also another type of case, chronic obstructive jaundice with benign tumors of the papillæ which are likely to be confusing as no palpable mass is discovered, and result fatally because no side tracking operation is performed. After having seen just such cases at autopsy and unoperated in Vienna, Doctor Beer concluded that such cases should be given the benefit of the doubt, an attempt being made to side track. Whether this side-tracking operation should be a cholecystogastrostomy or a cholecystenterostomy is a debatable point. Statistics have shown that anastomosis with gut may lead to inflammation of the gall-bladder and to multiple hepatic abscesses, while the sterile condition of the stomach favors the biliary passages. (Kehr had only one infection of the bile passages in sixty cholecystogastrotomies.)

DR LUCIUS W. HOTCHKISS thought that the cases presented showed the advisability of doing an anastomosis rather than mere drainage. He stated that he had had one experience some years ago with drainage where the sinus persisted for a long time, the patient finally leaving the hospital well, the patient later returned when a cholecystogastrostomy was done and the patient had remained well.

DR FREDERIC KAMMERER said that when the gall-bladder was automatically in such a position that it could be utilized for purposes of anastomosis, some palliative operation should always be done in these desperate cases. He was fully aware of the fact that cachectic patients, suffering from malignant obstruction, did not stand surgical interference well, even if only an exploratory incision had been done. But a few of his cases, where evidently a mistaken diagnosis of malignant tumor at the head of the pancreas had been made, had done very well after a cholecystenterostomy and had been observed for several years without infection occurring in the biliary tract.

DR CHARLES L. GIBSON endorsed the position taken by Doctor Downes

regarding the advisability of providing internal rather than external drainage in this type of case. He believed it impossible to tell in many instances whether one is dealing with a malignant or benign condition. He never has had occasion to utilize the stomach in anastomosis in such cases. Doctor Gibson stated that he brought up this subject in a paper read before this Society eighteen years ago, and that he was now ready to offer a contribution in the later history of a patient regarding the possibility of infection in anastomosing the gall-bladder to the small intestine, and a very definite proof of cure of chronic pancreatitis by proper internal drainage. The patient referred to was operated on while in a state of chronic jaundice under the diagnosis of carcinoma of the pancreas. An anastomosis was made between the small intestine and the gall-bladder, a section of the pancreas being removed for examination, the report upon this specimen was chronic interstitial pancreatitis. The woman got perfectly well, enjoying better health than ever before. Seven years after this operation she had a loose kidney operated upon, at which time Doctor Gibson took the opportunity to feel of the pancreas and found that it was normal. He considered this a cure both anatomically and physiologically. This patient has been under observation for ten years and in good health with absence of infection as the result of drainage to the intestine from the biliary passages. Doctor Gibson also stated that recently he had had occasion to make an anastomosis between the hepatic duct and the small intestine, a full report of which case he would present at a later date.

DR ALEXIS V MOSCHCOWITZ said that in the presence of so much unstinted praise for the operation of cholecystogastrostomy and cholecystenterostomy he hesitated to express his own opinions upon the subject, he felt compelled to do so, however, because in his experience the operation in cases of carcinoma of the pancreas had been unqualifiedly bad. In his opinion, even the performance of an exploratory operation frequently shortened the life of the patient, and he hesitated to operate whenever the history and physical examination leave no doubt as to this diagnosis.

DR WILLY MEYER believes one should attempt to ascertain whether he is dealing with a benign chronic pancreatitis or with a malignant tumor, but acknowledged that this was not always easy. At the same time, he said that if the patient had not lost much weight, and if in the presence of a chronic jaundice the patient states that he never had any colic, an examination of the head of the pancreas will usually locate the seat of the trouble. If this is very much localized, hard but not nodular, he believes one will not go far wrong in assuming the condition to be benign rather than malignant. He recalled a few cases of chronic pancreatitis in which he simply drained the gall-bladder to the surface for a prolonged period, and the patients were cured. In reference to malignant

infiltration of the pancreas anastomosis is, of course, the operation of choice. When using the first portion of the jejunum as in gastroenterostomy, or a longer portion and turning it over as in anterior gastroenterostomy, he has not seen infection of the bile-ducts. Still, it must be better for the patient to make the anastomosis further up, *viz*, connect the gall-bladder with stomach or duodenum.

Doctor Meyer said that too much stress could not be laid upon the benefit of the repeated subcutaneous injection of large doses of human blood serum two to three days prior to operation, stating that even in cases of true cholæmia the results of this method have been surprising in obviating secondary hemorrhage.

DR ELLSWORTH ELIOT said that for many years he had been interested in the treatment of simple benign stricture of the hepatic or common duct, or both. With regard to the anastomosis he stated that as a matter of fact the nearer the entrance of the common duct into the intestine the anastomosis is made the less likely is the development of subsequent ascending suppurative cholangitis. If an anastomosis at a distance from the mouth of the common duct is essential he considers an anastomosis above preferable to one below that level. Although he could not cite many cases of long standing from his own experience, yet from the experience of others he could recall several in which the end result was satisfactory in at least four and in one instance six years after operation following anastomosis between the stomach and the duct. Given a dilatation of the gall-bladder with dilatation of the common duct, the choice of the site of anastomosis is a difficult one to make. In all cases of stricture with mild dilatation of the gall-duct, only anastomosis between the dilated duct and the alimentary canal gives a more satisfactory result than between the gall-bladder and alimentary canal, the reason being that the biliary pressure within the duct, although normally low, is a more efficient barrier against the entrance of germs than is the negative pressure within the gall-bladder.

DR WILLIAM A DOWNES, in closing, stated that he used the stomach for the anastomosis because of the greater ease with which it is reached. He has had no experience with infection and he is inclined to believe that Doctor Beer's remarks were based on cases in which the anastomosis has been low, jejunal or colic, rather than to the stomach or duodenum. So far as Doctor Lilienthal's remarks are concerned, Doctor Downes was inclined to believe his first case not to be malignant because he is under the impression that cancer of the pancreas is a rapidly fatal disease. According to Doctor Erdman's statement, it is a question of months, not years.

GAUCHER'S SPLEEN

DR HOWARD LILIENTHAL presented a patient, forty-one years old, who had entered the service of Dr. Morris Manges at Mt. Sinai Hospital sev-

eral months before her transfer to the surgical service, to which she was admitted on May 22, 1916

Her father had died of tuberculosis. She had been operated upon for abdominal abscess seven years before at the Presbyterian Hospital. She had last menstruated nine years before admission.

For thirty-four years she had noted a left-sided abdominal mass slowly increasing in size. For a year there had been pain in the right hypochondrium together with some precordial pain with cough and mucoid expectoration. During this year there had been occasional night sweats and fever, and for ten years there had been occasional blood-stained sputum. For four months pain and discoloration of the lower extremities. An enlarged lymph-node in the left axilla had been removed, and on examination a structure suggestive of Gaucher's disease had been noted.

The blood showed a total cholesterol of 0.875 per cent. The patient complained bitterly of pain in the bones of her lower extremities and some pain in the arms. It was because of this symptom that she applied for treatment.

When first seen the operative risk did not seem very favorable. She was a small emaciated woman with an enormous mass, evidently the spleen, occupying three-quarters of the abdomen, the liver had dropped so that the right lobe was in the upper portion of the pelvis. There was clubbing of the fingers, pigmentation spots on the skin, and petechiæ of the conjunctivæ. The urine contained a trace of albumin and a few white blood-cells. Hæmoglobin, 45 per cent, red blood-cells, 2,000,000, white blood-cells, 1200, polymorphonuclears, 48 per cent, lymphocytes, 42 per cent, large mononuclears, 8 per cent, eosinophiles, 2 per cent.

On May 29, 1916, she was operated. The blood-pressure was 175 systolic. Both thighs were now ligated close to the body so as to segregate the blood and the pressure rapidly fell to 155 when it was noted that the pressure of the cuff on the arm had caused the appearance of petechiæ in the forearm. Examining the thighs petechiæ were also discovered here. In spite of this ominous sign, the patient was anæsthetized by Doctor Branower with ether by the open method and with the assistance of Dr Martin Ware the operation proceeded.

Incision from ensiform almost to the pubes through the left rectus muscle and this incision was continued along the border of the ribs to the flank. The lower portion of the spleen was now easily turned out and the hilum exposed. The large calcareous splenic artery was ligated and also a vessel which was thought to be the splenic vein, the hand inserted up to the diaphragm disclosed as much of the spleen as that which occupied the abdomen below. An enormous splenic vein was now found and in trying to encircle it with the aneurism needle it was perforated. The exposure was so perfect, however, that there was no

trouble in securing the vessel again. The lienorenal ligament was clamped in sections and the spleen cut away. A very large amount of blood came from the ablated spleen, spurting from it in a thick stream fully five or six inches away from the organ. All the arteries in the abdomen were apparently much sclerosed and calcified. The liver was of a peculiar yellow color and was greatly prolapsed, having been evidently dragged down by the spleen. The ligatures were then removed from the thighs and a small intravenous saline infusion given.

The wound was closed without drainage. Six hours after operation the patient's pulse was 132, but of a thready quality, although her general condition did not appear to be bad. However, 400 c.c. of blood were transfused by the direct method of Unger. In dressing the wound a heavy pad of non-absorbent cotton was placed over the abdomen so as to take the place of the removed organ. It was a case of Gaucher's disease. The patient made a good recovery and was discharged July 4, 1916, much improved.

A study of this case made by Dr. F. S. Mandlebaum, Director of Laboratories, Mount Sinai, will be found in the *American Journal of the Medical Sciences* of March, 1919. He reported the weight of this spleen directly after removal as 4250 grammes (nine pounds six ounces), but it must be remembered that probably two pounds of blood escaped from the spleen after it had been cut away from its attachment.

The patient is alive and active.

DR WILLIAM A. DOWNES said that in 1913 he had operated upon a case of Gaucher spleen which was later included in Mandlebaum's series. The patient was a woman, twenty-eight years of age, with conjunctival changes and pigmentation and other symptoms indicative of the typical text-book picture of Gaucher spleen, although the proper diagnosis was not made. At the present time, seven years later, the patient is in good health following operation.

TREATMENT OF INFECTED WOUND OF THE FOREARM

DR H. M. LYLE presented a man who on October 14, 1919, had been gored by a bull. The horn passed through the skin of the right forearm and came out in the cubital fossa, two jagged wounds resulting. The lower wound was 2 by 4½ inches and ran obliquely upward and outward across the forearm. The upper wound, 2½ by 7 inches, passed in a spiral manner around three-fourths of the circumference of the arm, following in a general direction the crease of the elbow. The wounds were sewn up. Forty-eight hours later he was admitted to St. Luke's Hospital with a badly infected forearm. The wounds were opened and a so-called Carrel-Dakin treatment begun. Smears from the wound showed innumerable bacteria. Cultures showed staphylococcus albus, streptococcus,

RESULTS OF FOLLOW-UP SYSTEM

and colon bacilli. Up to the 22d of October (seven days) little progress was made. On this date a strict Carrel-Dakin technic was instituted. Four days later there was less than one bacterium in the field. On the eighth day the wound was sutured.

He wished to demonstrate through showing this case what could be done by the strict adherence to Carrel technic and remarked that he had the good fortune to be in charge of one of the earliest ambulances which used the Carrel-Dakin method in its entirety, and that he had been able to follow the method for four years. In the hands of men who thoroughly understood the method it could be employed like an instrument of precision, and definite results prognosticated, and that on his return from France he had had an opportunity of going through one of our large military hospitals. A so-called Carrel-Dakin technic was being employed. One month later he went through the same hospital and had the pleasure of seeing a correct technic by a man who understood the methods. The results were as different as day from night. In other words, if you are going to treat wounds by the Carrel method, do it, but do not employ an imperfect technic and call it the Carrel method.

Regarding those who throw cold water on this method, he thought he could not do better than quote from Dr John Gibbon's article, "Advancement in the Treatment of Wounds and Infections Resulting from the War" (*Am Jour Med Sci*, clvii, 764). "The Carrel-Dakin treatment of infected wounds is one of the big things surgery has gained by the war, and the man who says there is nothing in it, that it is too cumbersome, or that there are a number of other methods just as good, has either never seen a hospital where the treatment was being properly used, or else he is so hide-bound that his opinion is worthless."

DR CHARLES L GIBSON in discussing this case begged that if a surgeon applies anyone's name to a method he is using, he follows the exact direction of the originator of the method, in which connection he cited various instances where it was stated that the Carrel-Dakin method was employed in the treatment of a case, but where in reality nothing like the method was used. Even in the hospital where he had personally instituted the accurate Carrel-Dakin method it was not being carefully followed, but all sorts of modifications were being made, and then discrediting of the method resulted.

AN ANALYSIS OF THE RESULTS OF SIX YEARS' FOLLOW-UP SYSTEM IN A SURGICAL SERVICE

DR CHARLES L GIBSON read a paper with the above title, for which see p 661, vol lxx.

DR JOHN H BRANNAN (by invitation) expressed his interest in the financial side of the follow-up system, stating that it was his desire to have a well-equipped and properly maintained bureau at the Bellevue

and Allied Hospitals, but that the expense of such a plan would not be carried entirely by the city. In the discussion of Doctor Gibson's paper he expressed the opinion that the author made out his results worse than they really were, because he tells of all the deaths of which he has report, but does not take into consideration the results in those cases which he has been unable to follow.

DR ROBERT T MORRIS stated that in his opinion in order to present scientific testimony in relation to hospital work it was necessary to develop elaborate and expensive systems, entailing not only work but special experience, a new responsibility for a new public. An enlargement of hospital facilities is also needed to the extent of caring for the patient whom we follow up. He seldom has proper after-care. A patient with tuberculosis is not cured after securing surgical relief, he requires treatment for tuberculosis in general. This must be maintained over a long period of time, including adaptation of climate, food, work, treatment by tuberculin, etc. The same criticism is made in cases of pyosalpinx many chronic gonococcus infections are amenable to treatment with vaccine, although some cases are not. In cases of ulcer of the stomach or duodenum the patient, having received surgical treatment, has received only first aid in his case, following this first aid it must be discovered what stands behind the ulcer. That means a proper medical examination of the sources of infection and the patient's whole economy. Therefore, more and more one is impressed by the fact that the follow-up system has merely opened up a larger vista of needs than the public ever has seen before, and the next step is to impress the public with this fact.

It is Doctor Morris' belief that the bad results in chronic appendicitis are due to the fact that appendicitis is so often spoken of as a diagnostic entity when it is so often really only a part of a whole representing in the irritated regions fibroid degeneration, lymphoid changes, which are presented to view, for this reason he considers that operations for chronic appendicitis are bound to be unsatisfactory unless better diagnostic work is done in advance of operation. A chronic appendicitis is only a part of a whole case in so many instances.

DR GEORGE WOOLSEY said that at Bellevue Hospital on the second division the follow-up system has been in existence for four years, and that in order to discuss some of the points in the paper before the Society he had looked up their own statistics, especially in relation to ulcer of the stomach and duodenum. He was impressed by the fact that one's prognostic ideas are often overthrown by the statistics developed. Some of these patients reporting three months after their operation will be recorded as in excellent condition, the same patients returning at the end of nine or twelve months may have some complaint and will be graded as showing only satisfactory or perhaps even unsatisfactory results, or the reverse may obtain, the reading of the statistics, therefore, depends partly upon the question of the time of their return.

RESULTS OF FOLLOW-UP SYSTEM

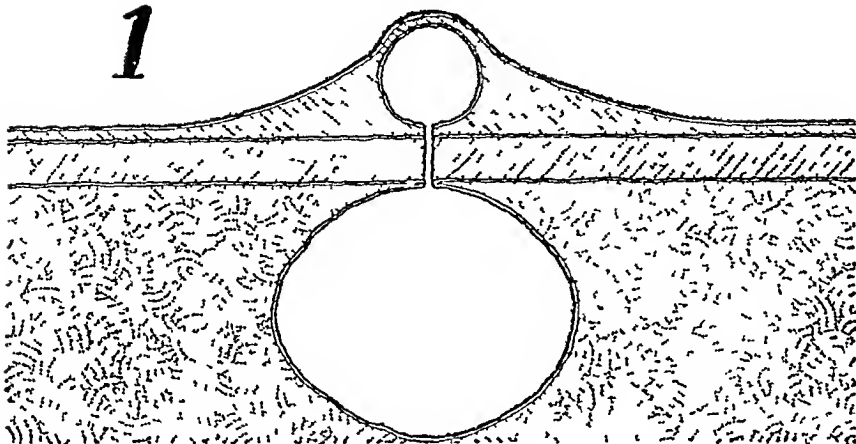
In considering the question of pyloric occlusion in duodenal ulcer, Doctor Woolsey stated that he had tried it in some twenty odd cases, and then made up his mind that it was of no use, only adding to the operation, and he has therefore not used this method for the past two years, he was surprised, however, in looking up these cases to find that the results in this group, where pyloric occlusion had been done, were the best of any in duodenal ulcer, the grading of excellent and satisfactory together amounted to 94.4 per cent. Another group of gastric ulcer cases where he expected more satisfactory results was that in which transverse or meso-gastric resection was done. In this group the primary results were excellent, but the ultimate results were not so satisfactory. He considered these cases disappointing. With regard to chronic appendicitis he considered it of interest to note that a number of cases of gastric or duodenal ulcer had had their appendices removed without relieving the symptoms, the primary trouble not being in the appendix, the same point is illustrated in the systematic removal of the appendix in cases of gastric or duodenal ulcer, where a large number show pathological changes. With reference to the perforating ulcers he had had only one case, operated on at the Hudson Street Hospital, no gastroenterostomy being done, in which, on later admission to Bellevue, a second operation was found necessary for recurrence.

DR ALEXIS V MOSCHCOWITZ considered the paper by Doctor Gibson one of the most valuable contributions ever read before the Society. He had made notes of a number of points which he wished to discuss, but owing to the lateness of the hour he would confine himself to that of chronic appendicitis, which, according to Doctor Gibson's statistics, showed, in about 30 per cent of the cases, a failure as far as a permanent cure is concerned.

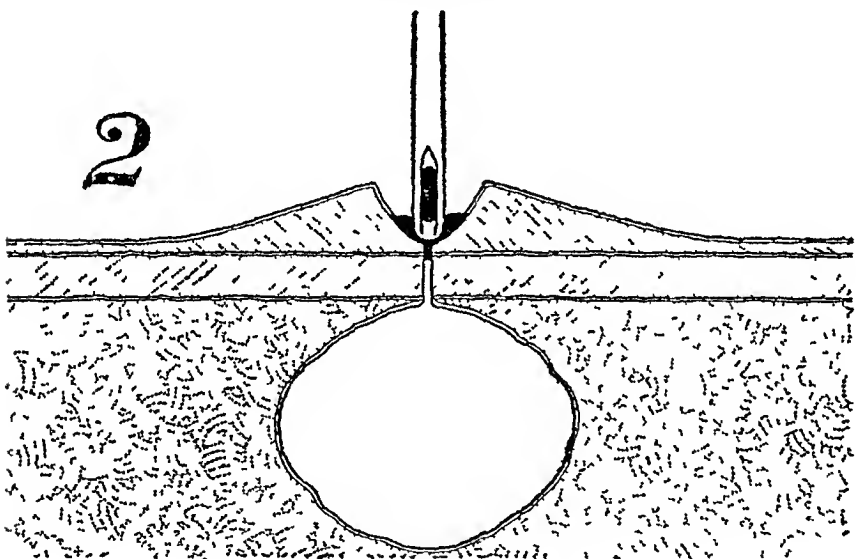
Cases of chronic appendicitis so-called had interested him for a number of years, and finally he arrived at the conclusion that from a viewpoint of prognosis all cases of appendicitis may be divided into only three classes. (1) Cases of appendicitis, or those in which the appendix always shows distinct evidence of disease, these, with the exception of those that died, get well, and more than that, they never have any trouble subsequently. (2) Cases which show very little pathologic change, some of these get well, and then they belong in the first group, some do not get well, and then they belong in group three. (3) Cases which show no evidence of disease, and never get well. They are the bane of the careless diagnostician, and of the surgeon who operates upon too slight an indication.

DR CHARLES L GIBSON, in closing, answered Doctor Brannan's question as to the financial side of carrying on such a system by stating that, with the exception of a very small and recent contribution, all of the work had been done at his own expense, and that he considered this the only satisfactory way of undertaking such a task.

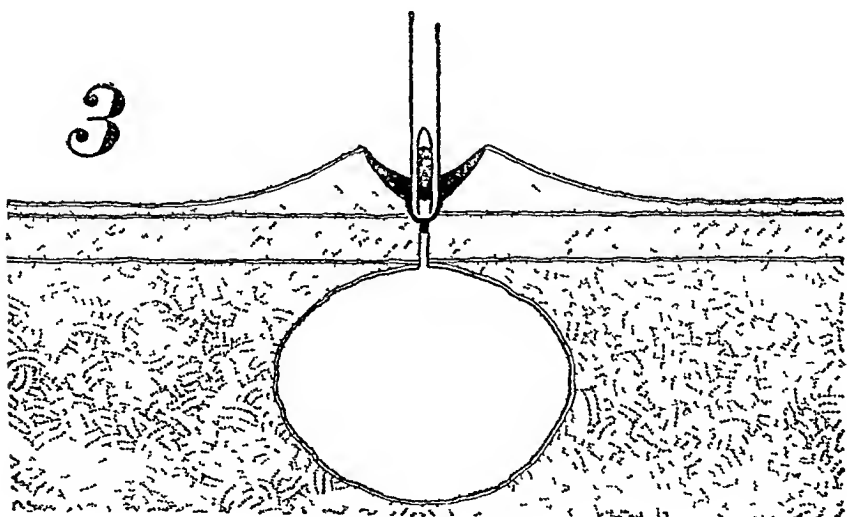
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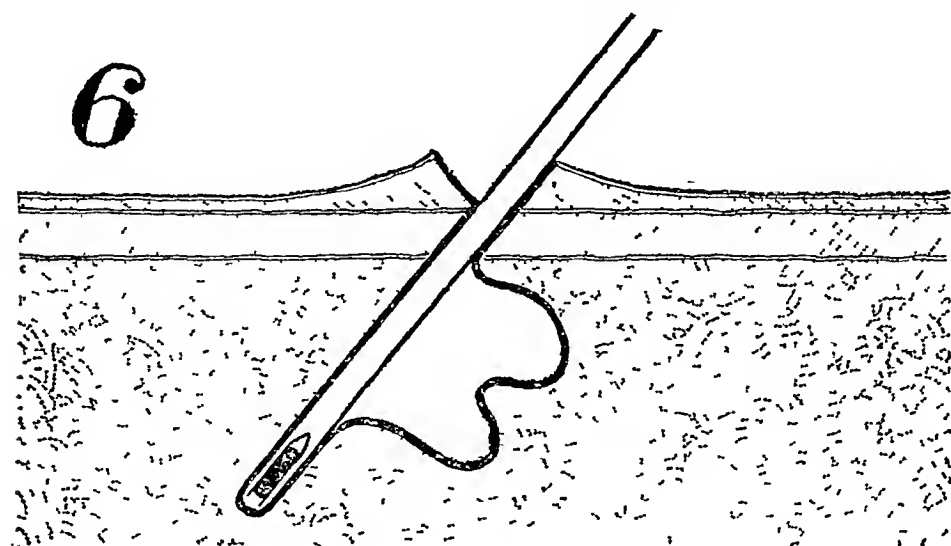
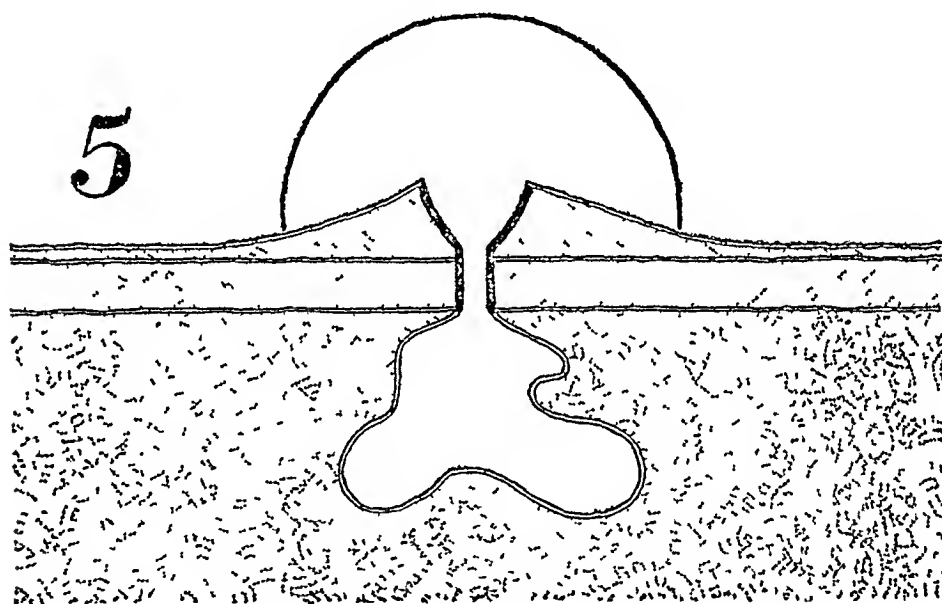
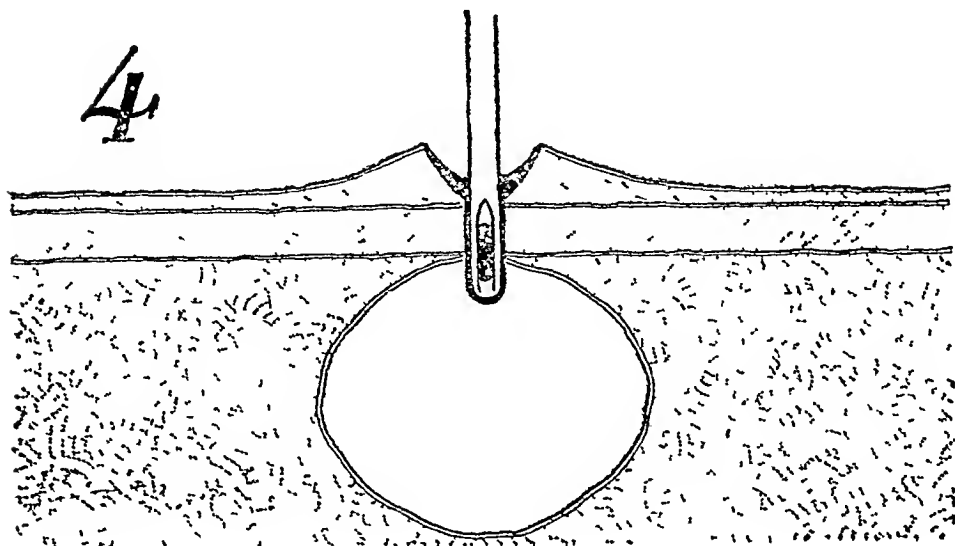
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AN ORIGINAL METHOD OF TREATING BOILS



NEW YORK SURGICAL SOCIETY

AN ORIGINAL METHOD OF TREATING BOILS

DR THEODORE DUNHAM presented a method which had the advantage of avoiding cutting, involving little or no pain, and as a result is followed by little or no scar, it utilizes 95 per cent carbolic acid in a very simple way, availing itself of three properties of this agent, namely, its anæsthetic property, its cauterant property, and its antiseptic property

First take the head off of the furuncle and evacuate the pus on the surface, wiping out the little cavity that remains. Take the eye of a surgical needle and plunge it into the 95 per cent carbolic acid, then begin to work at the bottom of the crater, after working at that for a little while a point of less resistance will be felt and that is the point where the little pore exists through which the infection crept down into the cellular tissue. By redipping the needle in the carbolic and working about this area one very readily anæsthetizes the tissues, this should not be done too quickly, a little time being allowed for anæsthesia, when the progress of the needle through the cutis vera is attended with no pain. Before long one will feel that the needle plunges into a cavity, in other words, it has gone through the cutis vera, and when this is accomplished one withdraws the needle and makes a little pressure. If there is pus in the cavity it will swell up to the surface. The next procedure is to reintroduce the needle, after dipping into carbolic, into the cavity and rather gradually allow anæsthesia to take place, reintroducing the needle several times, then sweep it about until the whole surface of the pus sac has been cauterized with the acid. When this has been thoroughly done some little blood serum will exude, indicating that the wall has been quite thoroughly cauterized. Very often on the following day it is found necessary to reintroduce the needle and recauterize the sac, sometimes this may even be necessary on the third day, but usually by this time all pain has disappeared and a little scab has formed, when there is nothing further to expect except absorption.

Stated meeting, held November 26, 1919

The President, DR WILLIAM A. DOWNES, in the Chair

BANT'S DISEASE—THIRD STAGE

DR EDWIN BEER presented a patient twenty-seven years of age who had been admitted to the medical service of Doctor Libmann at Mt Sinai Hospital in 1916, his chief complaint was vomiting of blood, pains in the upper abdomen, and black stools. On examination he was found to have muddy complexion, enlarged liver and spleen, with a systolic murmur at apex, his hæmoglobin was 33 per cent, red blood cells, 2,592,000, leucopænia with 6400 white blood cells, of which 71 per cent were polynuclears, 7 per cent large lymphocytes, 20 per cent small lymphocytes, 1



FIG 1 —Shows large shadow in left lumbar region opposite lower border of third lumbar vertebra

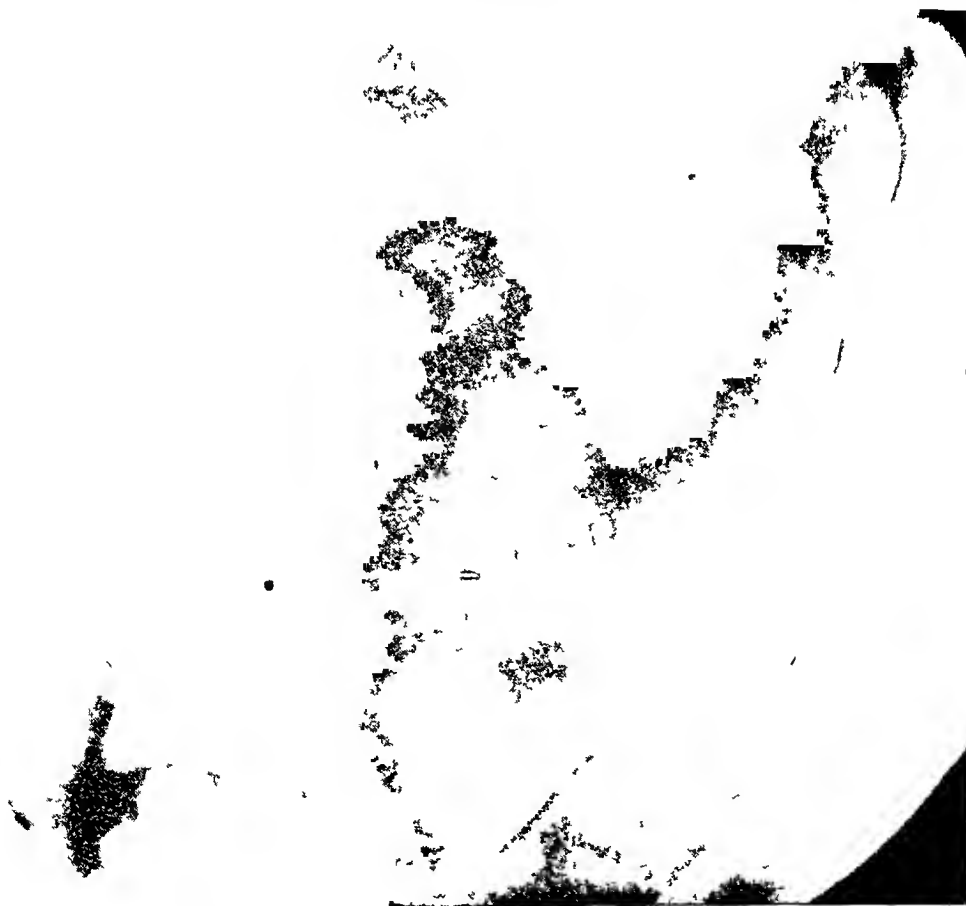


FIG 2 —Shows X-ray catheter passed up left ureter and pyelogram of left kidney The shadow in previous plate is well mesial to left ureter

FIG 3



FIG 4



FIGS 3 AND 4 —X ray showing catheter passing up right and left ureters and the right ureter evidently crossing the median line and reaching the stone shadow placed in the lower pelvis of the fused kidney

ANTERIOR PYEOLITHOTOMY FOR STONE IN FUSED KIDNEY

per cent eosinophiles, 1 per cent transitionals, 1 normoblast. On observation he had tarry stools, his spleen was 15 cm long, extending from the sixth interspace to 2 cm below the ribs, there was distinct ascites, and the liver was percussed from the fourth space to the free border. Wassermann test and urinalysis were negative. Subsequent blood counts showed a slight leucocytosis, at one time reaching 24,000. In other words, on the medical service the patient presented a picture of a large spleen, varying leucopænia and leucocytosis, ascites, and tarry stools, upon which a diagnosis of Banti's disease in the third stage was made.

On the 26th of October, 1916, Doctor Beer performed a splenectomy. At this time the abdomen was full of fluid, the spleen was four times its normal size, and there were omental adhesions to the parietes, the liver was hobnailed as in cirrhosis, and the splenic vessels were sclerotic. Splenectomy was fairly simple, the incision being L-shaped. After two and one-half weeks' sojourn on the surgical service the patient was returned to the medical side, although at that time he was running a temperature of 100° the temperature gradually rose and a subphrenic pyopneumothorax diagnosed. Again transferred to the surgical service, through a low incision the last rib was resected and the subphrenic pyopneumothorax opened by Doctor Beer. The wound closed rapidly, but six months later, in the scar from drainage of the chest there developed an abscess, through which the patient discharged a ligature which had been applied to the splenic vessels.

Up to the present time the patient has gained 40 pounds, now feels perfectly well, and a blood count made on November 12, 1919, by Doctor Gross showed red blood cells, 4,080,000; white blood cells, 7400, hæmoglobin, 78 per cent, the differential showing, 44 per cent polynuclears, 55 per cent lymphocytes, no transitionals, and 1 per cent eosinophiles.

ANTERIOR PYEOLITHOTOMY FOR STONE IN FUSED KIDNEY

DR EDWIN BEER presented a patient who had been admitted to Mt Sinai Hospital on April 18, 1919. He complained that for the last two years he had had pain to the left and below the umbilicus, in the left lumbar region, radiating to the spine and umbilicus. He also had hæmaturia at times. His physical examination was completely negative except for the abdominal condition. A few white cells and occasional red cells were found in the urine. To the left of the umbilicus and following in a measure the left iliac fossa, was a distinct mass, only slightly tender, and which had the consistency of kidney tissue. He apparently presented a typical picture of a left kidney stone in a low kidney, X-rays very distinctly showed a concretion to the left and below the umbilicus the size of a cherry close to the crest of the ilium in the left lumbar region (Fig 1). The patient was cystoscoped with the result that his bladder

and ureteral orifices were found absolutely normal, an X-ray catheter was then passed up the left ureter with the object of proving that the stone was in the mass felt on palpation, but contrary to expectations, the catheter passed several inches outside the mass, the pyelogram showing a very normal pelvis (Fig 2) Catheterized specimens from the ureters showed that the right ureter delivered no indigo-carmine, while the left secreted it very well, urea was 15 on both sides, there were some white blood cells obtained from the right ureter but none from the left It was then deemed advisable to pass X-ray catheters into both ureters, and in the left the catheter passed up to a normal but highly situated pelvis, in the right ureter the catheter crossed the spine and passed up to the stone in the left kidney (Figs 3 and 4) Upon this result Doctor Beer diagnosed a fused left kidney with no kidney on the right side At operation on May 5, 1919, the kidney was readily exposed, and through an anterior incision into the pelvis of this lower part of the kidney the stone was encountered and easily removed, the pelvis being sutured without leakage The patient made an uneventful recovery, and except for a transitory attack of pyelitis six months ago has remained perfectly well

During the operation, on examining the kidney, Doctor Beer could feel the vessels arising from the left common iliac and running into the lower pole of the fused kidney, and at the place where the lower part of the kidney was fused with the normal left kidney there was a distinct narrowing or bridge formation three-fourths the size of a normal kidney The ureter from the upper pelvis ran anterior to the lower part of the fused kidney

Doctor Beer considers the use of X-ray catheters extremely important in such a case, as without them there is always the possibility of realizing too late that there is not a second kidney upon which to depend if nephrectomy is the operation performed

EXCISION OF THE THYROGLOSSAL DUCT SINUS

DR EDWIN BEER presented a patient particularly to produce discussion upon the best technic to be followed in such cases He stated that this patient developed three and a half years ago an acute swelling in the middle of the neck from which a sinus opened and drained Seventeen months ago on admission to another hospital he was operated upon, the sinus apparently being excised Four months later the sinus recurred and another operation was performed On admission to Mt Sinai Hospital on May 1, 1919, a third operation became necessary and at this time through a transverse incision the sinus, after being injected with methylene blue which proved valueless, was removed Using a probe of heavy silkworm gut Doctor Beer was able to follow the sinus up to the body of the hybrid bone, and then having excised the sinus up to this point and

EXCISION OF THE THYROGLOSSAL DUCT SINUS

not finding any hole in the body of the hyoid bone, as in other cases, he excised the body of the hyoid bone and all fascia and connective tissue between the muscles above the hyoid bone in the median line up to the floor of the mouth without searching for an extension of the sinus. This wound was closed and a counter incision furnished drainage. The patient was re-examined in October, 1919, and no evidence of further trouble discovered.

DR JOHN F ERDMANN said that in regard to the excision of thyroglossal duct sinuses he considered these cases among the very hardest in which to obtain good results, as usually up to the present time it was more a question of luck than technic, nearly all cases undergoing multiple operations before someone happened to obliterate the sinus. Only a week ago he had operated for the third time upon a physician's sister, although at each previous operation he had been convinced he had reached the seat of the trouble. He now believes Doctor Beer's suggestion to take out the body of the hyoid bone, dissecting the muscles and fascia up to this point, as an excellent procedure, and when his former patient again presents herself for operation, which he considers more than likely, he will adopt this method.

DR A S TAYLOR said that it had been his fortune to see quite a number of these cases in Doctor Weir's practice, and that he had a few in his own. Doctor Weir had also found methylene blue unsatisfactory, for in dealing with a closed pocket, as in these cases, unless the needle reaches to the top of the sinus the blue fails to reach also and is ineffectual as a guide. He had seen some cases where the sinus ran through the hyoid bone and some in which it ran back of the bone. He advises making an incision in the median line above the hyoid bone, thus coming down on the tract, then eliminating the sinus above the hyoid bone to the base of the tongue, making a wide excision, when it becomes a simple matter to get the whole thing out, he then advises the use of a fine probe for the purpose of scraping the sinus in the bone, and so removing its epithelium and preventing further secretion.

DOCTOR BEER, in closing, said that it was surprising that a condition in which operation has so often proven unsatisfactory has never had a satisfactory technic worked out, for there must be some one method applicable to these cases. He had a small series of such cases following the technic which he recommends in his report as follows:

Inject the sinus with methylene blue (although rarely satisfactory), follow up to the hyoid bone on a probe of silkworm gut, making a wide excision of the sinus, resecting the hyoid body, follow up in the median line between the geniohyoid and geniohyoglossus muscles, taking even portions of the muscles and all the connective tissue and fat in the median line well up to the floor of the mouth. By this method he has obtained his best results.

SKIN GRAFTING

DOCTOR HOGUET stated that ordinarily there was more or less luck regarding skin-grafting, but he considered the method he had employed in these and other cases to be uniformly good in its results. This method was taught at the War Demonstration Hospital and is a modification of the Staige Davis method. The skin is taken up by a straight Hagedorn needle held in an artery clamp, the needle being flamed between each introduction under the skin, and a small amount of skin, varying in depth from the whole thickness of the skin to one-half its thickness, used for the grafts. The success of this method depends upon three essential factors, first, there must be an absolutely sterile surface upon which to place the grafts, and the best way to obtain this is to use the real Carrel method, second, the type and adjustment of the dressing for absolute immobilization of the grafts is essential. He advises the use of paraffine mesh gauze such as is obtainable from the Abbott Chemical Company, placed directly on the grafts covered with compresses soaked in Dakin's solution, these compresses are removed daily and resoaked, but the mesh gauze is not removed for about a week, when the grafts will be found to be firmly attached. Also on the surfaces from which the grafts are obtained a silver foil dressing is used.

The first patient, a middle-aged woman, while working in a hospital laundry had a portion of the laundry machine drop on her arm, producing two large wounds. Doctor Hoguet, happening to be in the hospital at the time, did a primary suture immediately, but the skin of both wounds sloughed. After Dakinizing one wound could be sewed up but the other surface was so large that the edges of the wound could not be approximated, therefore grafts were taken from the thigh and were not placed very close together. At present there is a very good result, every graft having taken.

The second case was that of a man who had a large necrosis of the skin from erysipelas. He was operated on at the French Hospital by Doctor Keyes on June 3, 1919, the grafts were placed close together. Of 107 grafts taken from the left thigh only 4 did not take.

The third patient had a large cavernous angioma extending from the occiput forward, for which he was operated in March, 1919. This growth had increased so in size that for a year the large œdematous mass hung over his eye and involved a certain amount of the eyelid. On removal of the tumor it was found impossible to bring the skin edges together, and therefore 171 inch grafts were put on the pericranium and one large thin Thiersch graft was placed over the eyelid in order to make a new eyelid. A silkworm gut suture running across the wound was held responsible for moving some of the original grafts, therefore, sixteen days later 50 more grafts were made. Of these 221 grafts all took. Even

though a difficult procedure his dressing for both head and eye was paraffine mesh gauze, and in addition over his eye were kept wipes soaked in salt solution, while the dressing over the head was saturated with Dakin's solution

Doctor Hoguet then presented a recently operated patient in order to show the appearance of these pinch grafts about a week after operation

DR NATHAN W GREEN asked that Doctor Hoguet state definitely how deeply he cut the skin for the grafts, and for how long a period he found it necessary to allow the paraffine gauze to remain

DR C A McWILLIAMS inquired what advantage these pinch grafts had over the larger Thiersch grafts of which fewer would be necessary to cover the areas. It was his opinion that Thiersch grafts took just as readily as the smaller pinch grafts. Doctor Hoguet had inferred that there was much greater doubt of the Thiersch graft taking than the pinch grafts. Why is there this difference in the taking of the two grafts? An advantage of the Thiersch grafts is that the treating of them is much quicker than the pinch grafts, because the cells of the latter grafts require time to spread out over the granulating surfaces between the grafts

DR JOHN F ERDMANN believed Thiersch grafts to be more useful than pinch grafts, and advocated the use of the Krause-Wolf method in grafts of considerable size. He also stated that he had not used Dakin's solution on skin grafts, although he had frequently performed this operation, and he believed that if the field were cleansed without Dakin's, a Thiersch graft transplant, covered with saline solution and gauze, keeping it moist for a week without redressing, the results would be perfectly satisfactory

DR J P HOGUET, in closing, answered Doctor Green's query that the depth of the grafts varied because in using a Hagedorn needle with which to obtain them it would depend upon how deeply the needle was inserted into the skin as to the thickness of the graft. As to the time that it was usually necessary to allow the paraffine mesh to remain on, this averaged about eight to nine days before the first redressing

In reference to Doctor McWilliam's remarks, Doctor Hoguet said that previous to sterilization with Dakin's solution he had never had any success with large grafts, no matter what method of dressing was used, but that he advocated the pinch grafts because they were so much more successful. He presented the present method because it was applicable for the use of local anæsthesia and because such a large percentage of the grafts always took. He modified the original method by the placing of his pinch grafts somewhat nearer together, also he found that where the patient is not his own donor for the graft it was necessary to find a donor with a non-antagonistic blood type in order to get the graft to take readily

CHOLECYSTECTOMY AFTER CHOLECYSTOSTOMY

DOCTOR HOGUET presented a patient who had been operated upon two years ago for cholelithiasis, a cholecystostomy being performed, from which she recovered. Returning to Doctor Hoguet about three weeks ago she said that she had been suffering for the past six months from the identical symptoms which she had formerly. Operation November 12, 1919, showed a moderately enlarged gall-bladder surrounded by a tremendous number of adhesions, going up on the surface of the liver, down on the right side from the ascending colon and duodenum and then on the anterior face of the stomach, cholecystectomy was done and on opening the gall-bladder a pocket in the upper portion was found as a result of the previous operation—the gall-bladder was distinctly pathological, having a red, hyperæmic, somewhat thickened wall with three or four small gall-stones. The interesting point was the closing of the upper portion of the gall-bladder by the infolding of the wall at the previous operation. The specimen of gall-bladder was exhibited.

CHRONIC APPENDICITIS

DR A S TAYLOR presented this case as being representative of the large percentage of so-called chronic appendicitis cases in which removal of the appendix has been followed by increased troubles rather than relief. Also, it suggests that attributing gastric disturbances to reflex influences from the appendix should be countenanced only after the essential disturbances of the stomach itself have been properly eliminated from consideration.

The patient, a young woman, twenty-two years old. Up to 1913 she was ordinarily in good health. At that time she began to suffer from periodic sick headaches, which gradually became more frequent and disabling. After two years, in 1915, her physician decided that she was suffering from chronic appendicitis with reflex disturbances of the stomach.

Therefore, the appendix was removed. The scar is only about two inches long, so that no abdominal exploration could have been done at that time. The removal of the appendix gave no relief to her sick headaches, but in addition to her previous troubles, there was a steady dull pain in the right abdomen. This pain seemed to have no relation to the taking of food. She was not troubled with gas formation or constipation. She had not lost weight. The pain from which she suffered was made worse by standing, was somewhat relieved by sitting in a crouching position, and by lying on her stomach. An abdominal belt has given some comfort, but no real relief. Her attacks of headache and accompanying vomiting have lately become more frequent and so severe as to interfere seriously with her work.

Physical examination shows her to be a woman of small size, well nourished and of fairly good color, though somewhat sallow.

The scar of her appendix operation is located at the outer edge of the right rectus muscle and is about two inches long. There is marked tenderness about this scar. At the outer edge of the right rectus, at about the level of the eighth costal cartilage is a small area of marked tenderness to pressure. There is no excess of gas in the abdomen, nor anything else to be made out in the examination. Doctor Goodridge stated that examination of the stomach contents, stools and urine showed nothing abnormal.

A gastro-intestinal X-ray series showed high fixation of the duodenum, showed marked gastropnoia and colopnoia. There was persistent unevenness of the duodenal cap and well-marked elongation of the first part of the duodenum when the patient is in the erect posture. Otherwise the series showed nothing abnormal.

Diagnosis of duodenal fixation by peritoneal fold was made because of the type of pain, the lack of essential digestive disturbance or constipation, the influence of the posture on the pain and the appearance of the pictures.

Operation was done July 24, 1917. A transverse rectus incision was made just above the navel. When the peritoneum was opened the liver presented in the wound and was normal. When the liver was elevated the duodenum was found to be held fast to the gall-bladder and the cystic duct by a firm fold of peritoneum which ran forward half way to the fundus of the gall-bladder, and was continuous with the edge of the lesser omentum. This double layer of peritoneum was divided with the scissors with practically no resulting hemorrhage. The duodenum, at the junction of the first and second parts, was held tight up against the cystic duct and the under surface of the quadrate lobe.

Before dividing the membrane it could not be budged at all by manipulation. After the membrane was divided, including the edges to the true lesser omentum, a moderate amount of pull downward on the duodenum mobilized it sufficiently for it to form an easy natural curve from the stomach outlet in place of the sharply angulated position it had previously maintained.

Its mobilization downward amounted to nearly 7 cm. The raw surface exposed by dividing the membrane was covered in by whip-stitching the peritoneal edges of the gall-bladder and the lesser omentum with fine catgut.

Further investigation showed very firm adhesion of the omentum to the upper end of the appendix scar. This adhesion was about the size of a quill and ran from the hepatic flexure, a distance of about 5 cm., to the scar. It was divided between double ligatures.

No Jackson's membrane was present. The stomach showed no intrinsic abnormalities beyond a moderate dilation. The wound was closed without drainage, and she was returned to bed in good condition.

Her post-operative course was uneventful. The sutures were removed

on the tenth day and there was solid primary union. She sat up on the eighteenth day and returned home on the twenty-first day.

Since that time she has improved steadily in general health and capacity for work. She has had none of her previous headaches with the exception of one which occurred while she was still in the hospital and which was the result of smuggled sweets. She is now practically perfectly well.

DR J F ERDMANN said that the description of the membrane in this case would lead him to believe that it was like that described by Harris, of Chicago, in the *Journal of the American Medical Association* some seven years ago—anterior mesogastric membrane producing symptoms of duodenal ulcer.

DR EDWIN BEER thought that as Doctor Taylor was presenting this case in connection with the paper by Doctor Gibson at the last meeting, he would take this opportunity to say that he was surprised that no one had asked Doctor Gibson at that time how the diagnosis of chronic appendicitis was arrived at in his case, because if the diagnosis is a mistake in the beginning no one can hope to cure such a condition by appendectomy. It is his opinion that the diagnosis of chronic appendicitis is one of the most difficult to make. In this connection he referred to a case seen by him and Doctor McWilliams having all the symptoms of kidney stone. But X-rays and the filling test of the pelvis as well as most careful kidney tests proved negative, then on filling the intestine by Bastedo's test acute pain was produced over the appendix. Doctor Beer had therefore removed the appendix, but about six weeks later the patient, reporting to Doctor McWilliams, asked why they had not removed the right kidney stone which later showed very clearly in X-rays taken at the Presbyterian Hospital. Doctor Beer believed that many of the so-called failures to cure chronic appendicitis were due to a mistake in the diagnosis.

DR CHARLES A ELSBERG stated that in many cases where the appendix had been removed for supposed chronic appendicitis, and the symptoms persisted, he had been able to prove the diagnosis to be wrong, in seven such cases he had to remove spinal cord tumors which had been the cause of the symptoms.

DR WILLIAM A DOWNES said that in this connection he had read not only Harris' description but also one by Ochsner who some years before had called attention to a similar type of band. He felt that if he knew he was going to encounter such a membrane in any case he would prefer to send the case to Doctor Taylor, as he had tried to separate such bands in various cases, but had never felt satisfied that he had relieved the patients. Speaking of operation for so-called chronic appendicitis he

FASCIA TRANSPLANT FOR RECURRENT VENTRAL HERNIA

reported a mistake in his service at St Luke's Hospital, where in the case of an English soldier the diagnosis of chronic appendicitis was followed by appendectomy, in answer to a letter from the "follow-up" it was found that the man had been operated upon in Brooklyn a few months later and a large gall-stone removed

DOCTOR TAYLOR, in closing, said that his attention had first been called to this condition by Doctor Harris' paper, and that for some time he had believed it to have been brought to light by Harris, but later found that several men, both in America and abroad, had already described more or less the same condition. In many of the cases reported the patient was said to have had an operation for chronic appendicitis previously, one or two had had previous operations for gall-stones. Of course, where one is dealing with post-operative adhesions, together with a congenital membrane, the results, as a rule, are not so satisfactory

FASCIA TRANSPLANT FOR RECURRENT VENTRAL HERNIA

DR HAROLD NEUHOF presented a patient, forty-eight years old, operated upon for gall-stones in 1916, and admitted to Mt Sinai Hospital in the fall of 1918 with a post-operative ventral hernia. This was repaired under general anæsthesia. Many omental adhesions were found and divided. Peritoneum and aponeurosis were freed, peritoneum was sutured, and the aponeurosis was overlapped with stout chromic sutures. After operation a severe pneumonia set in. About one month after operation the patient noticed the return of bulging of the scar and recurrence of symptoms. The bulging was progressive and could not be retained by a supporting belt.

Readmitted to the service of Doctor Lilienthal at Mt Sinai Hospital in July of this year, complaining of pain in and bulging of scar of previous operation and frequent cramp-like epigastric pains without vomiting. There was a long incision in the right hypochondrium presenting a large hernial defect that increased with coughing or straining. Physical examination of the chest disclosed an advanced emphysema with hyperresonant percussion, diminished breathing, and sibilant and sonorous râles throughout.

From the experiences encountered after the previous operation as well as the physical signs in the chest, it was determined that local anæsthesia only could be employed with safety to the patient. The defect in the aponeurosis was exposed and after its edges were freshened was found to measure 5 inches in length and $2\frac{1}{2}$ inches in diameter. Its shape was irregularly oval with the widest portion above. One side of the gap

being close to the free costal margin, mobilization of this portion was impossible, and it was evident that even with wide mobilization of the mesial margin approximation could only be obtained by suturing under tension. Accordingly a fascial transplant for the defect seemed the simplest and best procedure in this case. The transplant was removed from the lower portion of the iliotibial band where the structure is thickest and strongest. It measured 5 by $2\frac{1}{2}$ inches and was exactly the size and shape of the defect. It was fixed in place at 4 points with fine chromic sutures and interrupted sutures were placed between these points. The skin was closed over the transplant.

Primary union took place except at the lower angle of the wound where there was a serous discharge for a time and exposure of the lowermost portion of the transplant. This subsequently healed over by granulation. It is now four months since operation. The patient is free from symptoms. The transplant can still be felt as a firm plaque made prominent by having the patient bend backwards. The persistence of this plaque-like alteration of the transplant for many months after operation has been noted in other cases. The abdominal wall is not on the whole of good tone, but there is no evidence of recurrence of the hernia. There is no hernia or other abnormality at the site of removal of the transplant from the thigh.

DR WILLIAM A. DOWNES inquired if Doctor Neuhof was able, as a general rule in such cases, to separate the skin and peritoneum and thus to preserve the peritoneum intact. He had found it difficult to do in many cases and wanted to know if Doctor Neuhof would advise placing the graft directly over the omentum and intestines when the peritoneum was lacking?

DOCTOR NEUHOF, in closing, answered Doctor Downes' question by stating that he had not opened the peritoneum in this case, because at the previous operation it had been opened and many adhesions found, and he therefore did not consider it necessary to do more than repair the defect in the aponeurosis, and by making an incision to one side of the scar the cicatricial tissue could be readily excised. He believed that the peritoneal endothelium would grow over the inner surface of the transplant just as it does elsewhere over defects, in those cases in which it was necessary to implant fascia across a gap in the peritoneum.

CENTRAL LUXATION OF THE FEMUR

DR NATHAN W. GREEN reported a case seen by him at the City Hospital in 1914 of a man who had fallen from a third-story window, his fall

CENTRAL LUXATION OF THE FEMUR

being intercepted by a signboard. He struck on his left hip and sustained a severe injury, he could move his hip but with pain. The X-ray showed a broken acetabulum and the head of the femur pushed in. The patient was seventy-one years of age, of melancholy habit, and on pushing up the window he fell out. While in the hospital he was a little out of his head and could not be put in a cast nor could he be adequately immobilized because of his many bruises and the low vitality of his skin. He was therefore placed on a water-bed with practically free motion of his limb. He left the hospital in June, 1914, and had not been seen by him since that time. Doctor Green, however, obtained the report from his daughter that after being home a week he was taken to a hospital for the insane where he lived for about three and a half years, and that during that time he had walked without a limp. He had had no appliance or reduction of his injury, having been allowed constant motion.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held November 3, 1919

The President, DR GEORGE C ROSS, in the Chair

BONE TRANSPLANTATION FOR OLD UNUNITED FRACTURE

DR A B GILL presented L T, a girl ten years of age, from South Carolina, admitted to the Orthopaedic Hospital June 5, 1917. The brief history that was sent with her stated that she had a fracture of both bones of the leg above the ankle at the time of birth, that the fractures had never united, and that the patient had never walked on her foot but had always gone on crutches. Examination showed an ununited fracture of both bones of the leg above the ankle (Fig 1). The foot could be placed in apposition with the leg in any direction. There is a shortening of four inches.

June 18, 1917 First operation. The tibia was exposed and an inlay bone graft from the same tibia was placed to span the fracture. The graft was taken from the upper fragment of the tibia, and was turned around so that the upper portion of the graft was embedded in the internal malleolus. This was done in order that the normal bone from the upper portion of the tibia should bridge the gap between the fragments (Fig 2).

The leg was dressed in plaster for twelve weeks. On October 8, 1917, the case was removed. It was found (Fig 3) that the graft was broken at the site of the fracture. A second case was applied for another month at the end of which time non-union was still present (Fig 4).

November 16, 1917 Second operation. On exposure of the tibia it was found that the first graft had healed in, but had not been large enough, therefore, at the second operation another bone inlay of the entire width of the tibia was placed in a manner similar to that employed at the first operation.

Three months later it was found that no union had occurred. Radiograph examination showed a complete absorption of the graft and thinning of the tibia with an absorption of the lime salts. Patient was fed on bone marrow and had daily treatment by baking and massage to increase the nutrition of the leg.

April 12, 1918 Third operation. Tibia was exposed and tunnel drilled in the head of the tibia, and a second one in the inner malleolus. The surface of the shaft of the tibia of both fragments was planed off with osteotome, so that there might be fresh bleeding bone the entire length of the tibia. A large transplant was then

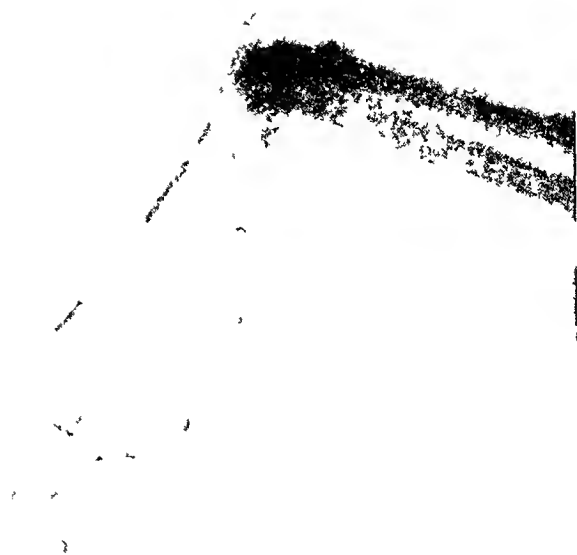


FIG 1 —Before operation

FIG 2 —Transplant bridging gap between the fragments

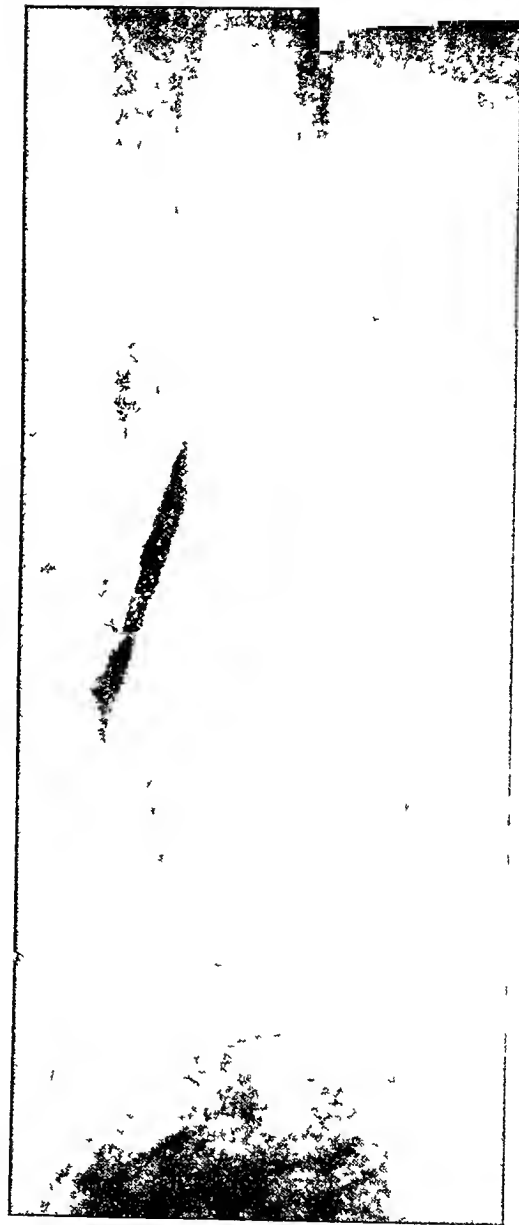


FIG 3 —Showing fracture of the transplant



FIG 4—Showing non-union still present

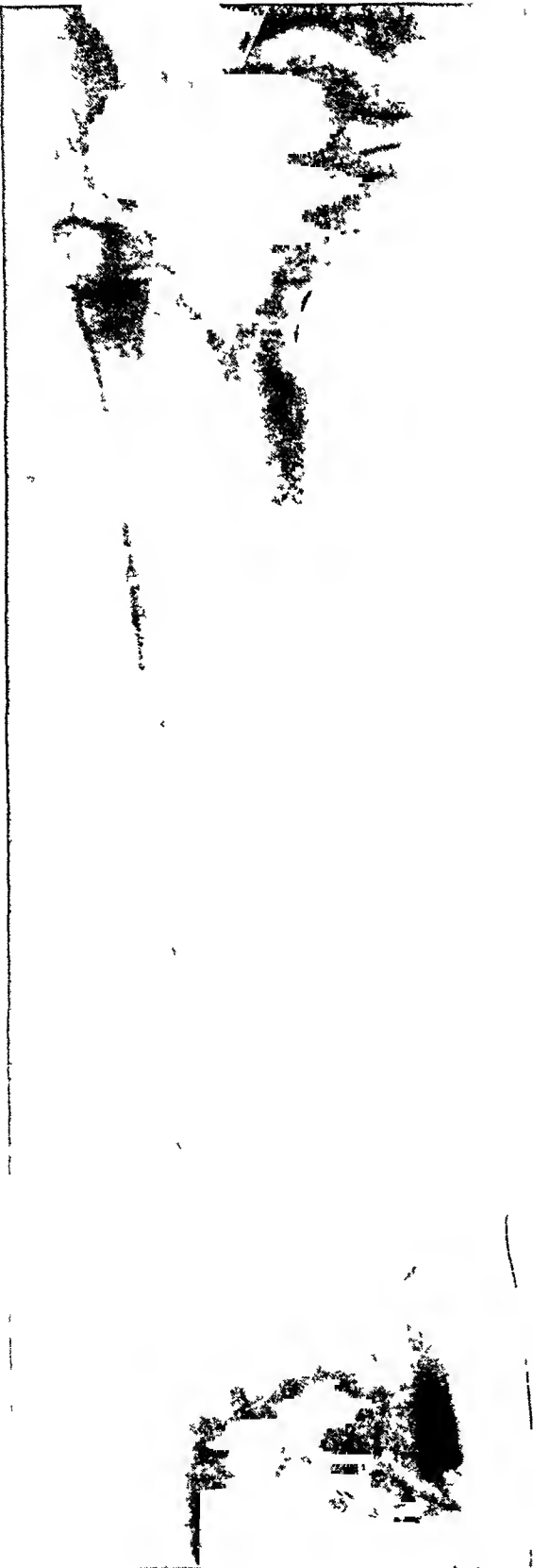


FIG 5—Five months after third operation, showing union between transplant and fragments, and growth of transplant

taken from the other tibia. Its ends were buried in the tunnels already prepared, and the medullary surface was held in contact with the shaft of the tibia by means of catgut ligatures. The leg was dressed in plaster. A new case was applied on the first of June. It was found that fairly firm union was present. A high shoe was fitted to the case and the patient permitted to walk and bear her weight on the case. When the second case was removed six weeks later firm union was present. The patient was fitted with a brace and a high shoe. September 25, 1918, patient was discharged. She had good union (Fig 5) and she was walking well by means of the brace and the high shoe.

This case is of interest because it demonstrates that union may be secured in an ununited fracture after a lapse of almost any number of years, and second, because it shows the futility of using too small a transplant. This patient would have been saved two operations if a large transplant had been taken from the other tibia at the first operation. This child has a shortening of four inches in her extremity which can never be made up. This shortening is due to the lack of development of the extremity because she did not bear weight on it. Had union with the fracture been secured earlier she would not have so much of a deformity and would not be so severely handicapped.

SPRENGEL'S DEFORMITY (CONGENITAL ELEVATION OF THE SCAPULA)

DR A B GILL also showed R T, a girl three years of age, who was born with a congenital elevation of the scapula. There is no history of similar deformity elsewhere in the family.

Examination on admission. The left scapula is elevated about $1\frac{1}{2}$ inches with only $\frac{1}{4}$ inch motion up and down, and with but slight motion on rotation. The upper angle lies in the posterior cervical region $1\frac{1}{4}$ inches below the mastoid process. The upper angle and the upper margin are distinctly hooked forward. The posterior margin has a marked angulation at its centre and forms an angle at this point of almost 90 degrees. From this point of angulation a distinct firm band can be felt extending to the sixth cervical vertebra. The scapula rotates about this angle where the band is attached. The child is unable to elevate her arm above her head, nor can the arm be placed in this position passively. The hand cannot be placed behind the neck.

At operation October 8, 1919. A curved incision about three inches in length was made just behind the posterior border of the left scapula with the lower end of the incision slightly below the middle of the scapula. Skin and fascia were divided. A plate of bone was found extending from the point of angulation at the middle of the posterior border of the scapula obliquely upward to the sixth cervical vertebra. The scapula in the region of this posterior angulation was cartilaginous. The angle of the scapula was excised with the plate of bone attached. A distinct articulation occurred at this

point It was then found that the bony plate could be moved freely through an articulation with the spine It was detached from the vertebra

The scapula could not be brought down to a normal position The trapezius muscle was separated from the posterior portion of the spine and the two rhomboids and the levator anguli scapulæ were also detached from the scapula It was found that the supraspinatus was made tense on attempting to move the scapula downward It was therefore loosened from its posterior attachment The angle and the upper portion of the scapula as far as the suprascapular notch was found to be sharply hooked forward This portion of the scapula was excised The scapula could then be brought down into almost normal position and there seemed to be no tendency for it to return Wound closed Child was put to bed on a Bradford frame with the left hand fastened to the upper part of the bed to maintain the arm in extreme abduction, and to rotate the scapula and hold the posterior border down

November 3, 1919 Wound is healed, and the scapula is in almost normal position, the lower angle being but very slightly above the lower angle of the opposite scapula The child's arm can be held above her head, and placed behind her neck There is free rotation and up and down motion of the scapula Daily active and passive exercises must now be given in order to develop and maintain free motion of the scapula and the upper extremity

DR J TORRANCE RUGH presented three specimens from cases of Sprengel's deformity upon which he had operated and all of which had the same characteristics as shown in Doctor Gill's case He had operated on four cases in twenty-seven years Three had had the extra piece of bone running in from the top or from the side of the spinous process, usually of the seventh cervical vertebra, and attached to the posterior superior angle or the posterior border of the scapula The most recent one had been done that morning in a child three years of age in the Methodist Hospital The long bony process coming from the side of the spine of the cervical vertebra or from the side of the lamina (the posterior aspect) extended down along the posterior border of the scapula It was attached to the scapula about one inch above the lower angle, that is, it was on the ventral side of the scapula The scapula was deformed much as the one Doctor Gill has shown, there being no posterior superior angle It was necessary in this case, because of hooking over of the posterior border of the scapula, to separate all muscular attachments and then cut off the upper border of the scapula After this it was easy to draw the scapula well down over the chest wall

The specimen shows a large piece of bone running from the spine down to the scapula and shows a reversion to one of the primitive types of the lower animals There have been a number of operations advised for correction of this deformity, but each case must be cared for in

TREATMENT OF NON-UNION IN COMPOUND FRACTURES

accordance with the conditions present Recently, one operator advised cutting a V-shaped piece up into the body of the trapezius muscle and drawing the scapula down That would be absolutely useless in a case such as Doctor Gill's, because the attachment or elevation is not due to shortening of the trapezius muscle, but due to the attachment between this bony growth and the scapula

DOCTOR GILL, in closing, stated that he detached the trapezius from the posterior portion of the spinous process of the scapula and did not notice whether there was any accessory process of the muscle or not He did not dissect out the muscle as he wanted to do as little injury to the parts as possible

The etiology of this deformity as mentioned by Doctor Rugh is interesting It is known that the upper extremity develops in the cervical region, and during foetal life descends to the position which it occupies at birth In Sprengel's deformity there has been an arrest of the normal descent of the upper extremity The cause of its failure to descend is not absolutely clear, but in cases such as the one shown to-night it is possible that the presence of the suprascapular bone will account for it

TREATMENT OF NON-UNION IN COMPOUND FRACTURES

DR DE FOREST P WILLARD read a paper with the above title, for which see page 182

DR JOHN H JOPSON said that non-union in gunshot fractures is, like suppuration, one of the reproaches of military surgery We have learned much as to its prevention in the course of the war The principles of prevention are much the same as hold true in the case of the industrial injuries of civilian life, and the knowledge we have gained is especially applicable to this class of cases Whereas in the early years of the war widespread excisions were done in the continuity of bones, the site of gunshot fractures, with a relatively large percentage of cases of non-union, it was soon clearly demonstrated that the solution of continuity of the periosteum in these cases was seldom complete, and the old principle of removal of totally detached splinters and the preservation of those only partially separated was, when combined with careful cleansing in the course of débridement, followed by much superior results in the way of prevention of non-union Satisfactory healing at the same time could be obtained The introduction in modified form by Leriche of the old Ollier technic, by which a subperiosteal resection was performed of such portions of bone as required removal in the course of débridement, raising with the detached periosteum a thin layer of bone cells, was of distinct value in certain classes of cases in which the fracturing missile had penetrated or perforated the bone, carrying with it, in the case of missiles of low velocity, an infection which may or may not have been present with missiles of other types In fractures involving the joints we also found it of advantage With Leriche's special form

of elevator this was a simple matter. In gunshot fractures, as in compound fractures of other types, the introduction of metallic plates is fraught with risks that constitute contraindications to its adoption as a safe and acceptable procedure. In a few cases of oblique fracture, as Blake has shown, a Parham band, or in a smaller bone a silver wire, can be placed around the bone ends as a temporary splint, with the expectation of removing it later. In the latter case it may "heal in" even when the superficial wound is not closed. Compound fractures of large bones were, of course, left open until demonstrated sterilized sufficiently for suture, and treated in the meantime by the Carrel-Dakin technic. Efficient traction and fixation are the factors, in addition to the proper operative handling of the wound, in the prevention of non-union. The employment of skeletal traction has been amply demonstrated to be of great value in this connection. We used it in the form of the tongs, with much satisfaction. Where there has been a considerable loss of substance the tongs must be retained in use for a correspondingly longer time, to avoid buckling of the bone at the site of excision, which we have seen occur following their early removal. The after treatment includes the care of the muscles and the preservation of the function of neighboring joints. In the treatment of non-union itself, the bone graft, judiciously used, is, as Doctor Willard has emphasized, the most generally accepted, and apparently the ideal form of treatment. Bad results have occurred by its too early use as well as by its indiscriminate application in the hands of partly trained surgeons. Another and simpler form of fixation, the results of which were very satisfactory in the hands of Doctor Graves of the orthopaedic services, was in the use of kangaroo tendon for fixation in operations for non-union. Two sutures were used, the bone ends each being drilled in two places, at right angles to each other, and the sutures being knotted in the same fashion. Satisfactory fixation was thus obtained even in the femur. Has Doctor Willard had any special experience with this method?

DR W HERSEY THOMAS stated that he favored the Chutro graft but that at the time of treating these cases he was using intramedullary apertosteal grafts. In one particular instance a tibial transplant had been placed in a radius to bridge a 6 cm defect following a gunshot wound. The case did well and one month later was transferred to another general hospital where his splint was inadvertently removed almost immediately after his arrival. When next seen, two weeks later, the graft had slipped out of the lower fragment and the condition was that shown upon the plate. In a second operation (twelve weeks after the first), the upper end of the graft was so firmly incorporated with the proximal fragment that it was difficult to tell the original graft from the proximal fragment itself. The lower end of the graft was brought back to its original bed in the distal fragment but fractured while it was being laced in position with kangaroo tendon. A second graft was then taken

ABSCESS OF THE PROSTATE

from the tibia and one end fixed in the distal fragment. The other end of the graft was laced to the original graft which had become incorporated in the proximal fragment. It is now three months since the second operation. The man has good union and can pronate and supinate.

The next case was that of an intramedullary bone-graft for a gunshot fracture of the upper third of the humerus. This man's wound had been healed for over a year and he had had a long course of massage and physiotherapy. Shortly after the operation the wound became infected with a hæmolytic streptococcus. The wound was laid open at once and Carrel-Dakin treatment instituted. Despite the infection and open treatment, this patient speedily gained a firm union and a good strong arm. Several sinuses remained for a few months, but he has now been solidly healed for six months and is enjoying the most active use of his upper extremity.

DOCTOR WILLARD, in closing, said that regarding the use of the kangaroo tendon in the femur cases, he had seen the cases of Doctor Graves at the Aberdeen Hospital in Scotland and they seemed to be healing remarkably firmly. He had treated a case of malunion in which refracture of the femur was done in which the fragments were held by that method. The forearm fractures were put in plaster of Paris, with a window for six or eight weeks. The cast was then cut in two, leaving a plaster-of-Paris mould, then began the treatment of light massage on the forearm, light motion to the fingers was started immediately and further motion as soon as possible. The mould is kept on so long as the X-ray shows there is need of it, perhaps for four months. In a femur case in which the operation was done in October, the cast was not taken off until December. Yet distinct bowing in that femur occurred. In another case the cast was kept on for at least four months.

ABSCESS OF THE PROSTATE

DR ALEXANDER RANDALL read a paper with the above title, for which see page 172.

DR D B PFEIFFER stated that it had always seemed strange to him that prostatic abscess was not more frequent than is the case. That when one examines the prostate microscopically as he had done several years ago in many cases, one is impressed with the number and narrow calibre of the glands that ramify deeply within the stroma of the prostate. Often the signs of chronic inflammation with cellular infiltrate are found, but it is seldom that the cellular deposit is within the lumen of the glands and the polymorphonuclear leucocyte is much less common than the round cell. In other words, the microscopical evidences of acute inflammation and pus formation are usually lacking. This corresponds with the relative infrequency of abscess as observed clinically, while chronic inflammation and indeed acute inflammation without abscess are commonly found. It would seem that the muscular stroma

possesses in common with muscular structures elsewhere in the body special facility in dealing with infective processes whether by rapid absorption or by its ability to keep the ducts open by intermittent contraction

In view of the relatively uncommon character of the condition, this series reported by Doctor Randall is in reality an extensive experience. He had recently seen a report of 30 cases of prostatic abscess by two French observers which were the number encountered in 10,000 consecutive cases of genito-urinary conditions. The conclusions reached by a study of this series approximate very closely those stated in the paper we have just heard. The majority of the cases were very closely related to antecedent venereal disease, but instrumentation did not play any marked rôle in exciting the attack. The striking feature of these cases is the severity of the local and general symptoms, and there can be no difference of opinion as to the necessity of early incision and drainage.

DR LEON HERMAN said that he was interested in the small proportion of cases of prostatic abscess in Doctor Randall's series due to specific cause. Undoubtedly, the majority of such abscesses originate as complications of gonorrhœal urethritis. He could not agree in all respects with Doctor Randall's viewpoint regarding the treatment of these cases. The mere suspicion of pus was not in his judgment sufficient justification for perineal incision. In the absence of systemic symptoms sufficient to warrant the diagnosis of the presence of pus, he believed the great majority of these cases should be treated palliatively.

If the local examination reveals the presence of abscess, however, these cases should be operated upon regardless of the absence of systemic reaction. Acute retention of urine occurring during the course of acute posterior gonorrhœal urethritis is usually considered pathognomonic of prostatic abscesses, but to this rule there are important exceptions. One case occurred which necessitated catheterization for a period of three weeks. There was in this instance an enlarged and tender prostate, but the local findings were not characteristic and the systemic symptoms were very slight. This individual recovered without operation and he felt sure that rupture of an abscess into the urethra did not occur.

Periurethral or periprostatic abscesses can be drained perineally only after traversing an approximately normal prostate gland to reach them, a procedure of doubtful propriety. True prostatic abscesses should, of course, be operated upon without delay. There is, however, little justification in my judgment for operation in cases where the symptomatology and physical findings are indefinite and inconclusive.

He agreed thoroughly with Doctor Randall that these abscesses should be drained perineally where the necessity for evacuating them arises. The majority of them can be ruptured intra-urethrally by the passage of a sound and at least 65 per cent will rupture into the urethra spontaneously. Not only in chronic disease the aftermath of this sup-

posedly happy termination of the abscess but the danger of rupture into the other areas is too great to justify procrastination

He had recently seen at the Pennsylvania Hospital a patient with a urinary fistula of the left inguinal canal. The left testicle had been removed for tuberculosis epididymitis, following which he developed an abscess of the prostate. This ruptured spontaneously both into the prostatic urethra and through the abdominal wall with the formation of a urethro-abdominal fistula.

Prostatic abscesses of gonorrhœal origin have been known to terminate in this same manner.

DOCTOR RANDALL, in closing, said that he felt that these cases should be operated and operated early. The important element was to save the patient from urethral rupture. It is almost a daily experience to see cystoscopically the after results of bad prostatic infections with the picture of deep sinuses leading down into the prostatic gland. Conditions are presented which on the first view tell you that you cannot rid the man of infection with its attendant symptoms. He thought, therefore, that in any case with symptoms of prostatic abscess the earlier incision was done the better.

BOOK REVIEW

GYNOPLASTIC TECHNOLOGY By ARNOLD STURMDORF, M D Philadelphia,
F A Davis Company, 1919 Octavo, cloth, pages 322

The *raison d'être* of this volume is the author's opinion that gynoplastic operations have heretofore in a large degree been based on erroneous theories of pathology and unjustified clinical deductions which have for many years had authoritative sanction. He claims that the prevailing principles and practices can not be defended either theoretically or practically in view of the actual anatomical structures involved.

The chief chapters of interest are those dealing with tracheloplasty and with the consideration of endocervicitis, perineorrhaphy, cystocele, fistulae and the various forms of congenital malformations.

The book is profusely and adequately illustrated with schematic drawings and one is immediately struck by the author's facility of demonstrating his procedures clearly. In all instances he develops the etiology of the various conditions, presents the pathology and shows the reason why certain steps must be taken in order to eventually accomplish certain desired results, and then elaborates the operation proposed based upon these considerations.

The text is readable and interesting. Particular notice should be directed to his treatment of chronic endocervicitis.

Briefly, his method consists of an enucleation of the endocervical mucosa from the external to the internal os and then the accurate relining of the denuded cervical canal by a cylindrical cuff taken from the vaginal sheath. The descriptive illustrations of this operation are particularly full and enlightening. In accomplishing the second stage his technical method of suturing is most ingenious. He condemns very correctly cervical curettage as of doubtful efficacy. He draws attention to the fact that success does not in a large number of cases follow the reapposition of the edges in lacerations of the cervix unless one appreciates the pathology of the coexisting infection which almost universally accompanies these lesions. There is but little question that the correlation between carcinoma of the cervix and a long standing chronic catarrhal endocervicitis is an intimate one, and too active attention cannot be drawn to this pre-cancerous state of irritation.

Throughout the book, in cervical work as well as in dealing with the perineum, the reasons why other surgeons have failed is shown most graphically, and one can on every page learn a practical lesson in technic which may serve him well.

The author's consideration of the mechanism of the intrapelvic support and of the pelvic fascia will well repay close attention. While his-

torical references are given due consideration, the author mentions other observers and their work in order to better establish his own methods in like conditions, and does not attempt to describe previous operative procedures which in his view were basically and anatomically incorrect

The reviewer, however, does not see why, in the consideration of exstrophy of the bladder (on page 245) the operation of Mayo should be discarded in favor of that by Peters merely because of the statement that the higher percentage of cures obtained by Mayo may be due to his personal operative skill¹ And one must certainly concede that the principle of dynamics which Mayo has so successfully employed, as suggested previously by Coffey, of implanting the ureters in the rectal wall, is technically more sound than that employed by Peters Certainly Mayo's results are unique and have not been approached by any other surgeon, which would indicate that his method should be the one elected instead of being discarded, as it apparently is, by the author

The book will, however, repay its reader on account of the clearness with which difficult questions are discussed

JAMES T PILCHER

CORRESPONDENCE

TRAVELS OF A WIRE IN THE ABDOMEN

EDITOR ANNALS OF SURGERY

This record of an unique case is offered for publication in the ANNALS. Mr R. T., aged 40 years, entered the Broad Street Hospital, in New York, on June 18, 1919, stating that he had accidentally swallowed a wire something over five inches long, which he had employed with a small swab for making some application to the posterior nares. The fluoroscope employed at once showed the wire in the upper part of the œsophagus, the upper end on a level with the larynx. The patient suffered very little discomfort from the presence of the wire. While preparations were being made for seizing the wire, another fluoroscopic examination showed that the wire had moved down to the stomach. It rested in the long axis of the patient's body, one end of the wire remaining in the œsophagus while the remainder of the wire transversed the stomach in its own axis.

I advised conservatism in treatment, believing that a wire which could make the round of the pharynx might possibly make the round of the pylorus, and I preferred to defer operation until some need for operative procedure was apparent. Most of us have seen so many foreign bodies traverse the alimentary tract in a harmless way that the mere presence of a wire in the stomach would not necessarily call for operation. My assistants, Dr Sullivan and Dr Hammett, argued that a wire in this particular position would be likely to perforate the wall of the greater curvature of the stomach. There really did seem to be such a danger.

The patient was anæsthetized and the stomach opened. The wire was not there, although the fluoroscope clearly showed it in the œsophagus and stomach a few moments in advance of the etherization. There was some speculation as to what might have become of the wire, but we felt that in the course of some efforts at emesis made by the patient while going under the anæsthetic, the wire must have been transferred to the long axis of the stomach and passed through the pylorus. The wound was closed and we planned to make another radiograph as soon as our operative wound had healed, not wishing to move the patient to the X-ray room in the interval unless untoward symptoms developed. Nothing unusual occurred in the course of repair of the wound and there was no undue abdominal tenderness at any point suggestive of the presence of a wire in the free peritoneal cavity. There was no evidence of obstruction in the bowel at any point. The patient's vital signs showed very little variation from normal. The only point worthy of note, perhaps, was the fact that there seemed to be more gas formation in the bowel than would be accounted for by any ordinary disturbance of digestion.



FIG 1 —Wire in free peritoneal cavity after perforating stomach without causing any notable harm



FIG 2 —Wire at rest upon fundus of bladder after traversing peritoneal cavity harmlessly

Twenty days later, the wounds having healed, the patient was taken to the X-ray room, and the wire was found to be outside of the stomach or bowel in the free peritoneal cavity as shown in Figure 1. Other radiographs, beside the one here presented, were made with bismuth in the stomach and bowel, but as the bismuth obscured the wire for picture purposes the radiographs are omitted from the present publication. A series of radiographs taken during the next few days showed that the wire was moving downward in the peritoneal cavity, and two days later it came to rest in the pelvis at the point shown in Figure 2. At this point it remained without further change, and as there were no symptoms indicating its presence I was inclined against operation, believing that it would become encapsulated in peritoneal exudate. One end of the wire, however, appeared to be so close to the iliac vessels that I feared the effect of any further movement of the wire when the patient was walking about. Consequently a suprapubic incision was made and the wire was found encapsulated in peritoneal exudate upon the anterior surface of the fundus of the bladder. The wound healed without complications. I am inclined to believe that the wire would eventually have perforated the bladder and might perhaps have been removed by way of the urethra. There would have been no leaking into the peritoneal cavity because of the amount of peritoneal exudate sealing in the site of the wire.

ROBERT T. MORRIS, M.D.,
New York, N. Y.

DOUBLE INTERVAL ECTOPIC WITH RETENTION OF SIX-MONTHS FŒTUS

EDITOR, ANNALS OF SURGERY

Prenatal anomalies are not unusual and historical writings of abnormalities are profuse. This case report is presented, not that it represents anything new or startling in obstetrics, but that it is unique in character. The salient points are the patient's predisposition for extra-uterine pregnancy, in that both tubes at different periods of time were involved, the retention for two years and three months of a known six months' fœtus that incapacitated the patient, the prejudice against operative interference, and the second ruptured tubal pregnancy.

Mrs. G., aged twenty-eight, was admitted to St. Vincent's Hospital October 2, 1919, with a symptom complex indicating double ectopic pregnancy with an interim of two years and three months with the retention of fœtus.

Menstruation began at sixteen, regular, no dysmenorrhœa, duration six days. Married at twenty-six. Three months later menstruation ceased and was associated with nausea and vomiting, abdominal distress after eating, with cramps and diarrhœa. This continued for five months, when menstruation was reestablished, represented by a continuous flow for three

weeks, ceased for two weeks and then became regular up to July, 1919, when the phenomena developed a second pregnancy. Menstruation ceased and again she suffered from nausea, vomiting, and diarrhoea. On the evening of October 1st, after eating a pear, abdominal distress and pain were severe and continuous and were associated with vomiting and diarrhoea. The patient, pale and anæmic with thready pulse, was nearly exsanguinated.

Physical examination shows a tender abdomen with rigid muscles. Much pain in right lower quadrant. Lower left quadrant, a large irregular mass nodular and of two prominent portions easily determined by sight and palpation. The patient was cognizant of this mass in February, 1917, and noticed its growth till July, 1917, when she had her first severe attack of pain, cramps, vomiting, and diarrhoea, since which time it has remained stationary.

The diagnosis of ruptured extra-uterine pregnancy was confirmed at operation. On opening abdomen, cavity was filled with blood and a ruptured right tubal ectopic was evident. Right salpingectomy was performed and attention directed to enucleation of the foetus in the left quadrant. The sigmoid had completely enveloped its superior and anterior borders, while below it filled the pelvis and was firmly attached to the pelvic colon which showed evidence of compression. Left salpingo-oophorectomy was performed with removal of foetus enclosed in sac intact. The patient made an uneventful recovery and was discharged from hospital October 30, 1919.

WILLIAM H. FISHER, M.D.,
Toledo, Ohio

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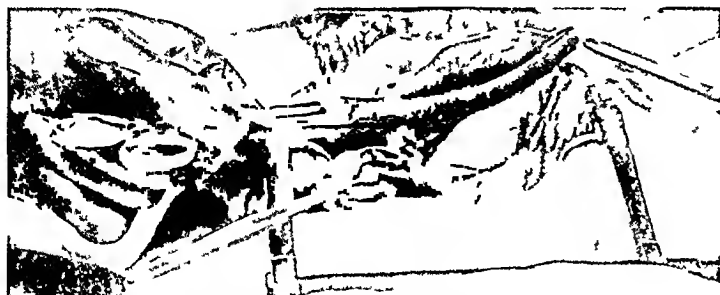
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FIG 1 —Six months foetus removed after two years and three months retention in abdomen A, head B, thorax, C, legs and thigh, D cord with remnants of sac, E placenta

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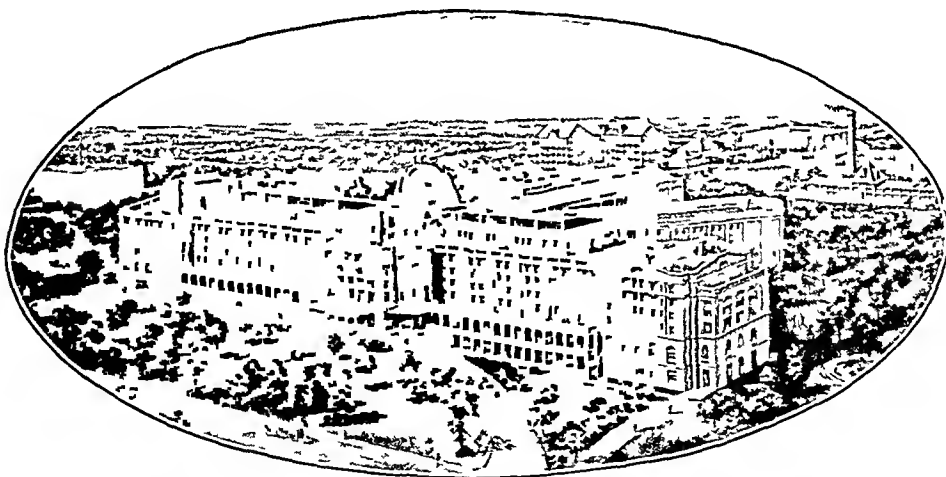
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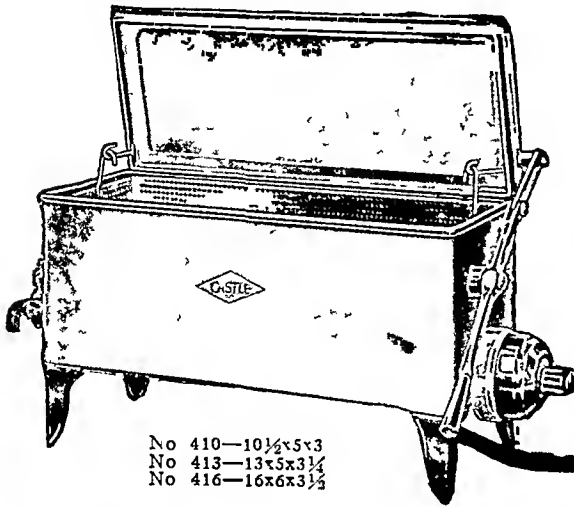
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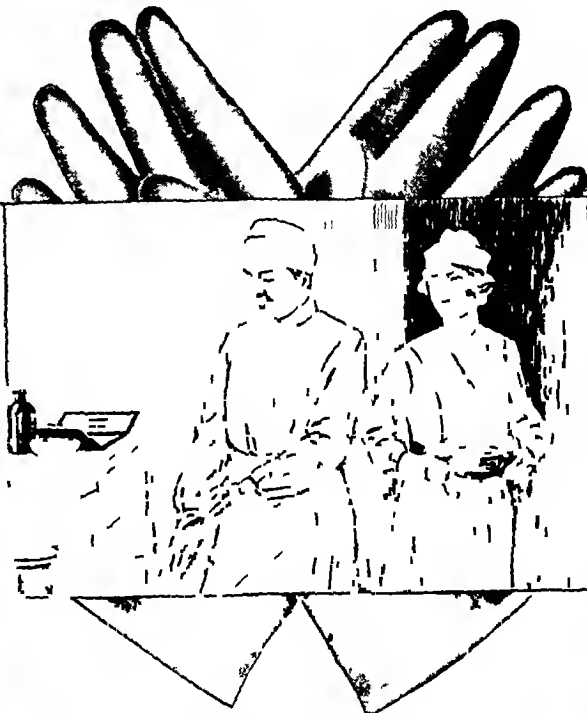
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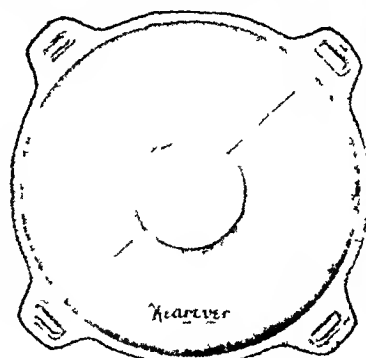
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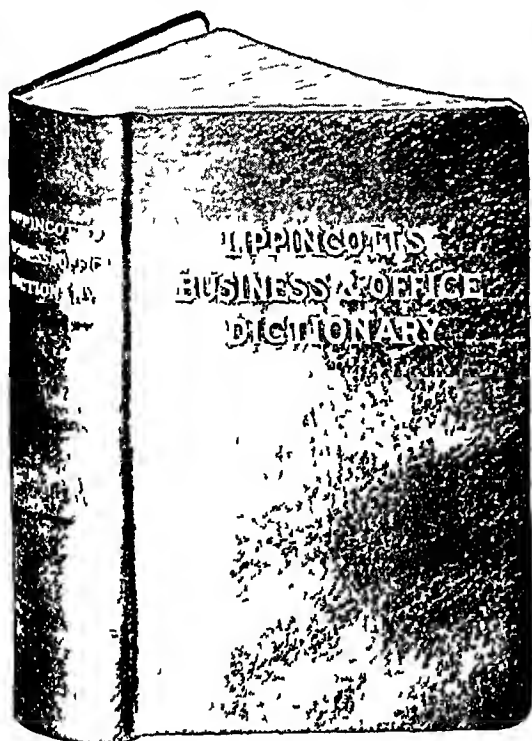
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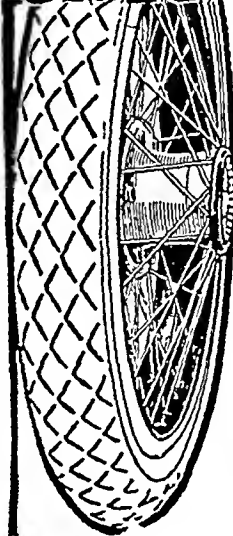
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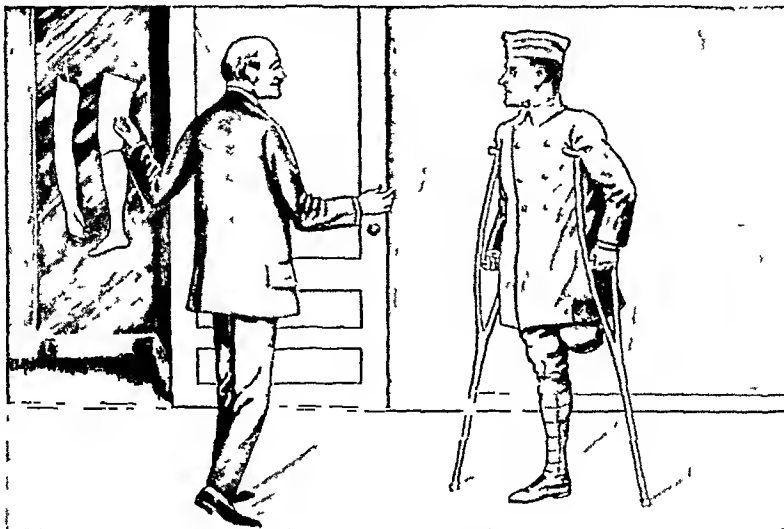


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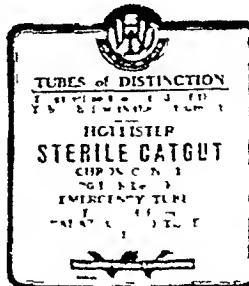
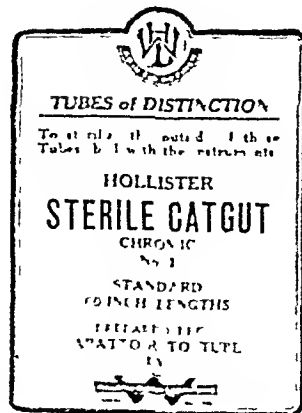
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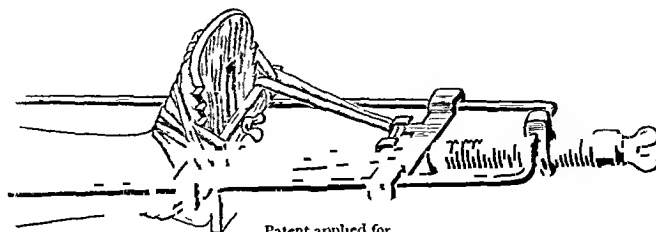
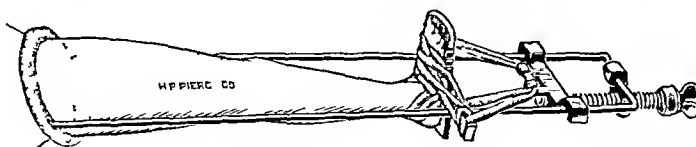
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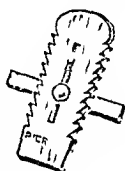




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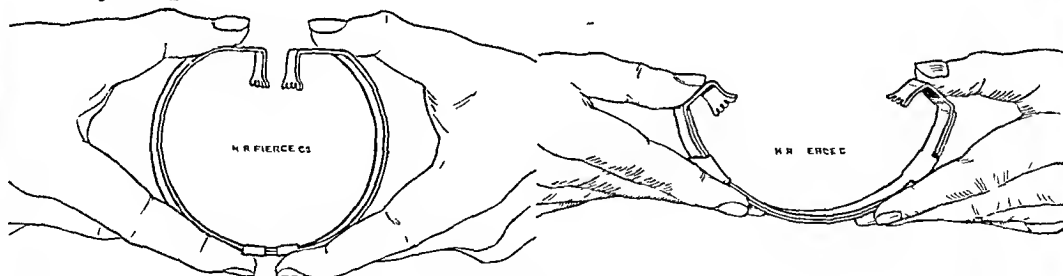
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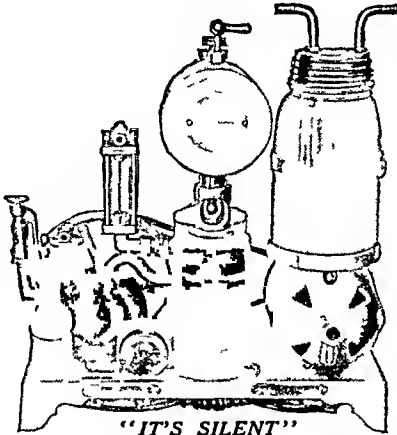
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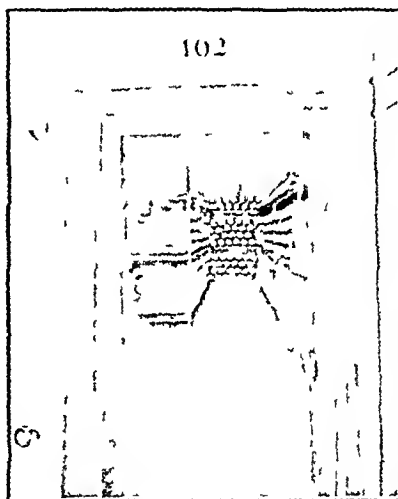
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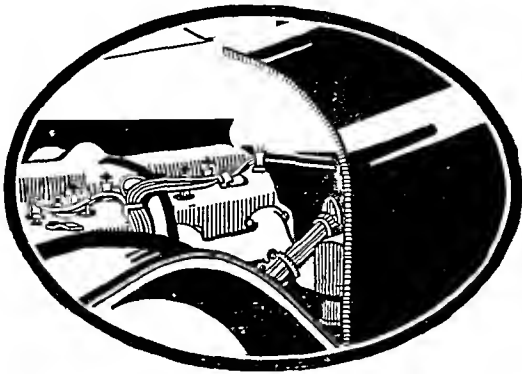
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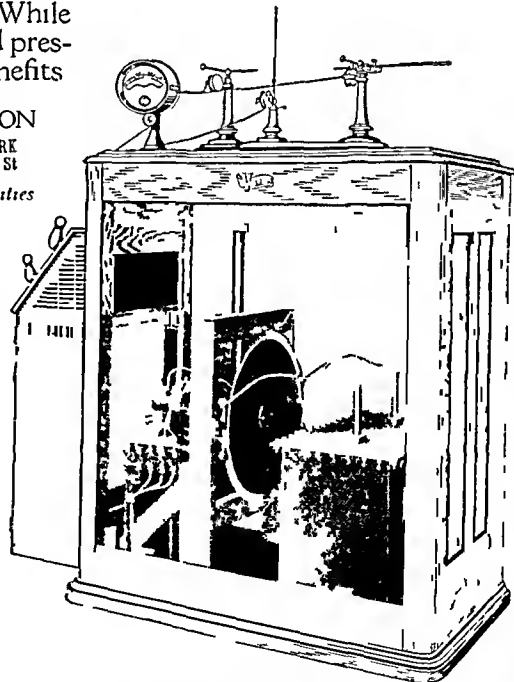
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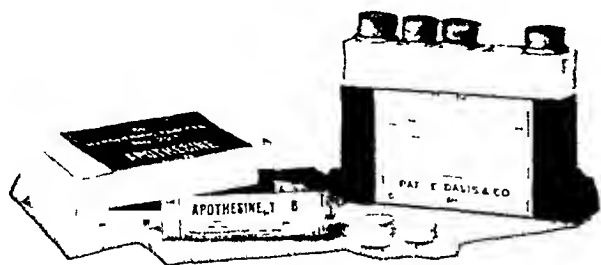
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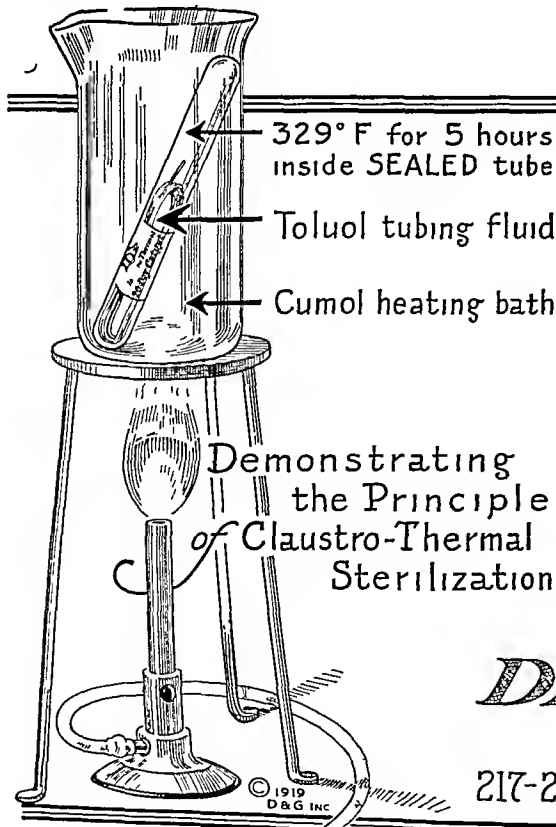


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POSSIBLE ADVANCES IN CIVIL MEDICINE SUGGESTED BY EXPERIENCES IN TREATING WAR INJURIES OF THE CHEST*

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THE war taught anew and emphasized as it has never before been emphasized that successful treatment entails more than preventing an immediate fatality. The other elements to be considered are the preservation of normal local and general function, reduction in the duration of disability and protection from increased liability to subsequent disease. From this viewpoint diseases of the chest present opportunities for therapeutic progress and for wide service, the equal of those offered by the rest of the body.

Preservation of the structural and functional integrity of the pleural cavity is the chief objective in medical and surgical treatment of pleuropulmonary disease or injury. This is to be achieved through the restitution of mobility of the thoracic parietes, of intrapleural negative pressure and of pulmonary elasticity. Under these conditions normal respiration and pulmonary circulation are possible, and only under these conditions can occur the sudden and wide compensatory variations required by the fluctuating activities of ordinary life.

The most important feature in both medical and surgical therapy is the prevention and relief of pleurisy. Pleurisy is the commonest indication for treatment, the most frequent cause of failure of intrathoracic operations undertaken to relieve other diseases, and, if uncontrolled, it leads to serious and often to permanent impairment of parietal mobility, intrapleural negative pressure, and pulmonary elasticity—hence to some degree of incapacity.

Pleural reactions to irritation should be considered from two angles. First, the local and general effects common to serositis, and second, the specific effects peculiar to pleurisy.

Serositis is characterized by an abundant sero-fibrinous exudate and a tendency to the formation of adhesions between contiguous surfaces. Both the profuse exudate and the adhesions are natural defensive reac-

* Read by title before the American Surgical Association, June, 1919.

† The work upon which the communication is based has been generously assisted by the Research Division, American Red Cross, under the direction of Dr. Alexander Lambert.

tions, both are inevitable steps in repair, and, if uncontrolled, either may exert unfavorable influences upon ultimate recovery. An early formation of adhesions is desirable to bottle up an area of irritation, to enmesh bacteria and thus to restrict a dissemination of irritants while local and general resistance are being developed. The earliest subsequent elimination of these adhesions is desirable, and can be influenced by treatment. Adhesions are eliminated by being so gradually disrupted that the denudations produced are immediately overgrown with serosa cells. Excessive disrupting force by causing too great mechanical irritation serves to aggravate the existing lesions. Adequate force is best supplied by active motion which is controlled by reflex pain inhibition. Fibrinous adhesions are formed in four to eight hours, and their organization is definite in three to four days. The most favorable time to begin active motion is when the dangers of acute infection are passed, so that the possible liberation of bacteria through tearing adhesions may be tolerated. These facts have been recognized in methods of treating peritonitis. Willems¹ and Delrez² have proved they are applicable to arthritis, and they hold equally well in pleurisy.

The effects of the serous exudate, which is always profuse, are determined by the rapidity of absorption. In the belly where absorption is so rapid as to amount almost to perfect drainage, there is little accumulation about or diffusion from the primary focus of reaction, but there is danger of over-intoxication. In the synovial and pleural cavities accumulation of excess exudate is the rule because of a low rate of absorption. The lesser dangers of immediate intoxication are more than compensated by disadvantages. Accumulation of a fluid within a cavity means hypertension and a corresponding anæmia, the separation of serous surfaces assures lessened resistance and greater diffusion. Serous exudates usually contain some of the original irritant and are therefore dangerous, but even though they contain none, they are of themselves sufficiently irritating to induce a similar though less active sero-fibrinous reaction on normal serous surfaces to which they are diffused.

The anatomic reaction of all serous surfaces is quite identical, the serosa cells exhibiting remarkably high powers of resistance and regeneration. Consequently, the explanation for the variations in resistance of different serous cavities is clear. In general, the larger the cavity, the more adaptable its walls, the richer the blood supply of its limiting membranes, particularly the visceral deflection, the more rapid the absorption, and the higher the resistance. Natural methods of defense show the peritoneal cavity which spontaneously prevents the separation of serous surfaces has the highest resistance. Clinical methods which prevent this separation of serous surfaces, or if separation has occurred, produce a reapposition of these surfaces, offer the optimum opportunities for recovery. Artificial drainage, introduced so as to imitate physiological absorption, is required.

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The specific effects of pleuritic reactions upon parietal mobility, intrapleural negative pressure, and pulmonary elasticity are equally positive indications for relief

Parietal Mobility—Assuming integrity of bones, joints, and cartilages normal motion in the chest parietes depends upon unimpaired function of the muscle-nerve combinations concerned in producing inspiration

Acute pleurisy causes a prompt inhibition of motion in the elevators of the ribs and in the diaphragm. The diaphragm, unlike other muscles affected reflexly by irritation of structures with which they are associated functionally, becomes immobile in relaxation instead of contraction. Intra-abdominal pressure causes the affected side to rise to an abnormally high level. The more intense the pleurisy, the greater the degree of diaphragmatic paresis, the more prolonged the pleurisy, the greater the probability that the paresis will become paralysis. Immobility of the diaphragm is of great value in the early defense against infection, providing conditions favorable to the maximum blood supply and the most effective degree of the restriction of motion. Permanent paralysis is a handicap contributing materially to exertion dyspnoea.

Prevention of diaphragmatic disability is one of the most urgent demands for the early treatment of spontaneous pleurisy and for the prevention of pleurisy after thoracotomy. It is another indication for drainage.

Intrapleural Negative Pressure—Deviations from normal negative pressure cause interference with respiration and circulation. Slight reductions are evidenced by dyspnoea and palpitation upon exertion. Abolition of negative pressure causes asphyxia because pulmonary inflation ceases. A small collection of fluid suffices to produce effects because variations in pressure are not confined to one part or to one side of the chest, as Graham and Bell³ have shown. The least harmful abnormality in negative pressure obtains so long as pleural surfaces are opposed. This argues against artificial pneumothorax as a therapeutic measure and is another indication for drainage where effusions are present.

Pulmonary Elasticity—If a portion of a lobe does not inflate normally, it affects the entire lobe by acting like a splint. If the inflation of one lobe is sufficiently impeded, the motion of the entire side of the chest is reduced. The longer a lung is compressed, the more difficult reinflation becomes, and, should atelectasis be combined with compression, reinflation soon becomes impossible. A subjacent cortical pneumonitis is constantly provoked by an acute pleurisy. Its extent and intensity varies with the intensity and duration of the pleurisy. This form of parenchymatous inflammation is almost certain to go on to organization and becomes an additional restriction to inflation. It is relieved ultimately, as pleural adhesions are eliminated, by active motion—respiration.

Again arises the same problem, the limitation of the extent, duration, and intensity of the pleurisy, and the same solution presents itself—drainage.

Up to this point an outline of the more significant pleural reactions has been attempted to establish principles of treatment which shall work in conjunction with natural processes of defense and repair. Similar reactions in the lung and in the parietes remain to be considered.

Pulmonary defense and repair is more important in protecting the pleura than in safeguarding the lung parenchyma, which is one of the most resistant and smoothest healing tissues in the body. Fortunately, the conditions which give the greatest protection to the pleura have the same influence upon the lung. Repair of tissue in general is fostered not so well by absolute immobilization as by the restriction of motion, which prevents too great traumatism and at the same time assures an adequate blood supply and the continuation of nerve activity. The optimum point of restricted motion for the lung occurs with a reduction in negative pressures which corresponds to that produced by an immobile diaphragm. This assertion is based upon Cloetta's⁴ experiments, Middleton's⁵ experimental and clinical observations, and upon the natural methods of defense in pneumonia.

Surgical repair of incisions into lung tissue should be designed to assure the immediate resumption of respiration. Adequate hæmostasis and aerostasis is easily obtained. Mass suturing is not permissible, layer repair with multiple fine stitches is required. Closure of visceral pleura must be air tight.

It is obvious that after thoracotomy the chest should be closed with the lungs inflated in order to reestablish intrapleural negative pressure. Pulmonary inflation is best accomplished by a method of intratracheal hypertension attainable with nitrous oxide and oxygen pressure analgesia.

Repair of parietal wounds, including surgical incisions, centers in the immediate healing of parietal pleura. The smoothness of this healing so dominates the reduction of dangers of pleurisy that sacrifices must be made to obtain accurate serosa to serosa approximation and without suture tension.

The significance of these simple details in repair was established by clinical and postmortem observations upon wounded soldiers during a service at the Ambulance de l'Océan at Lapanne and by experimentation in the Laboratory of Surgical Research at the Central Medical Department Laboratory, A E F.⁵ At this laboratory a group detailed by Doctor Finney devised methods for practical application of the principles involved. These methods were then used in treating the wounded in advanced hospitals. During a period when the wounded were received promptly and in good condition, the immediate mortality rate, which included two weeks after operation, was four per cent. This was the only period open to fair judgment because delays in transportation at other times made the average duration from injury to operation about twenty-four hours and increased the mortality rate ten times. These experiences together with observations made since the war upon late results obtained

in the wounded and in civil practice indicate possibilities of progress along certain lines of treatment

Early drainage in acute pleurisy and primary drainage at the time of thoracotomy have been discredited because of faulty methods employed and not because drainage under these conditions is contraindicated by its antagonism to physiological processes. Willems and Delrez showed that joint drainage by simple arthroscopy and early active motion to furnish the expulsive force and to eliminate adhesions gave recovery with splendid function. Simple air-tight one-way drainage of the chest employing the increased intrathoracic pressure of inspiration and of coughing as expulsive and disrupting forces is similarly effective. Suction should not be used. The proper intercostal insertion of a catheter by means of a trocar and cannula is hardly more serious than a thoracocentesis and provides constant drainage with minimum irritation. Bowditch first showed what early and repeated aspiration could accomplish in the treatment of pleurisy.

A catheter drain armed with a one-way flap valve, inserted when pleurisy is incipient, is only a continuation of Bowditch teaching. This modification will be accepted when two facts are recognized. The first is that an early diagnosis of sero-fibrinous pleurisy can be made and fluoroscopically confirmed before it is possible to aspirate fluid with certainty without the aid of a fluoroscope. This stage corresponds to early acute appendicitis. The second is that empyema which is a late stage of sero-fibrinous pleurisy is as flattering commentary upon clinical methods as purulent peritonitis arising from appendicitis. Both are confessions of therapeutic failure. Even after empyema has developed, catheter drainage should be tried first, with or without lavage with Dakin's solution as conditions demand. This simple treatment may obviate open operation and will usually reduce its magnitude if it becomes indicated later.

Primary drainage after laparotomy was found to be harmful because the general peritoneal cavity cannot be drained and because all forms of drains increased instead of reducing intraperitoneal irritation. Primary drainage after thoracotomy has been discredited because it did not preserve intrapleural negative pressure and therefore assured pulmonary collapse. Drainage of the pleural cavity is easy and pleural irritation slight if the tube is introduced so as to avoid undue contact with the visceral pleura. Thoracotomy is invariably followed by serous effusion which is so extensive as to be easily demonstrable on the second or third day. Its dangers are so definite that many of the best surgeons follow Bowditch's teaching by having their patients aspirated as a routine at this time. The aspirations are repeated at intervals until fluid disappears.

All intrathoracic surgical operations can be performed under nitrous oxide and oxygen analgesia and the degree of inflation or deflation of the lung can be suited to the operative requirements. This method, de-

veloped by Doctor J T Gwathmey's following up a lead given by Doctor Crile, is superior in doing away with deeper narcosis required to introduce intratracheal or intrapharyngeal tubes and utilizes the cylinder pressure of the gases instead of any more or less elaborate apparatus to provide differential pressure. Above all it is safe if used with reasonable care.

The significance of diaphragmatic relaxation in protecting the repair in lung and pleura is not appreciated. It is a natural method of defense and should be induced therapeutically. For instance, if the phrenic nerve be blocked by injecting one per cent cocaine in the early steps of a thoracotomy, the operation is facilitated by reduced motion and the recovery after operation is more certain, more rapid, and less distressing. This paralysis lasts four to five days and then gradually disappears. The pain incidental to pleurisy caused by malignant growths can be materially reduced by dividing the phrenic in the neck or injecting it with alcohol. Possibly the most important indication for inducing diaphragmatic palsy is in the treatment of pulmonary tuberculosis of the type now combated with artificial pneumothorax and for reasons stated above. Individuals with diffuse pleural adhesions which make artificial pneumothorax impossible could be given the same advantage. The injection of alcohol into the cervical trunk of the phrenic in concentrations suitable to the desired duration of paralysis can be done easily under local anæsthesia. Dogs are little embarrassed if both phrenic nerves are blocked, so possibly the diaphragm may be paralyzed on both sides in the tuberculous with advancing bilateral lesions. There is no evidence that a paralyzed diaphragm seriously interferes with the raising and expectoration of morbid bronchial secretions.

These principles applied to surgical methods make thoracotomy a safe operation because they afford a control of pleurisy and protect respiration and circulation. It were folly to attempt to predict the attainments of intrathoracic surgery in the immediate future, so great are its possibilities.

The same principles applied by internists will reduce the incidence of empyema, relieve much of the distress of tuberculous pleurisy, and probably improve the results obtained in treating pulmonary tuberculosis.

An increasing recognition of the frequency of impaired diaphragmatic function resulting from slight attacks of pleurisy indicates the greater attention which must be given to the prevention of late complications by early active motion of the lungs as soon as curtailment of the acute process permits. The importance of deep and free respiration becomes more and more evident. Preventive and therapeutic measures to obtain desired results are determined by thoracic physiology. Much remains to be learned, and there is scarcely a laboratory or clinical worker who can avoid finding some suggestion for renewed activity if the problem is considered broadly.

The demand for manpower during the war caused the development

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of methods of treatment which would return the wounded to duty in the least time and competent for indefinite service. The demands of peace times are the same, though the recognition is less general. There is not one law of tissue repair for war and another for peace. Function will always depend upon tissue integrity. If the knowledge of repair gained by war medicine is applied to civil practice, and with the same end in view, the death, distress, and disability prevented will soon exceed that caused by the conflict.

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WAR WOUNDS OF THE CHEST*

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THIS paper is based upon fifty-one operative cases of wounds of the thorax involving the chest wall, the lungs, and thoracic contents, or associated with injuries to the diaphragm or abdominal viscera. It is limited to the immediate operative results obtained in a hospital working in close proximity to the battle line and is not concerned with the treatment or mortality of such cases in the hospitals on line of communication or at the Base. The surgical material represented about 36 per cent of our entire operative experience. In certain sectors the percentage of wounds of the thorax to other wounds varied, depending upon whether the surgical team operated in a field ambulance, a mobile hospital, or an evacuation hospital. The proportion of chest cases received was directly proportional to the proximity of the hospital to the front line and correspondingly the greater the percentage of mortality.

In our experience the surgery of the chest embraced three distinct phases. The first period was a policy of non-intervention and at the height of a push or an offensive the attitude of "laissez faire" was employed. There were a number of reasons for this inactivity. In the first place, the wounded ordinarily did not arrive at the hospital until some time after their injury and had passed the golden time for operative treatment, namely, four to eight hours after receiving the injury. In our own personal cases the average time of arrival of wounded chest cases was 19.7 hours, while the earliest time was four hours, and the longest ninety-six hours. At the height of an offensive a complete chest operation with special surgical team and equipment required so much time and organization that few hospitals could provide the same or allow to be deflected so much professional talent for such work. From an army standpoint the time and ability of a surgical team could be more profitably employed on other and less grave injuries, so that from a distinctly military point of view it was wiser to adopt an attitude of non-intervention during the stress of a big offensive.

The second period began with the Marne Campaign of 1918 when the American service had adopted an attitude midway between non-intervention and so-called radical surgery. The surgical teams exercised wide latitude in interpreting the varying signs calling for operative intervention. It was not long, however, before a surgeon appreciated the essential fact that open or sucking wounds of the thorax should be closed for mechan-

* Read before the American Association for Thoracic Surgery, June 9, 1919

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cal reasons alone, irrespective of the infection likely to ensue. The first operations that most of the surgical teams were able to do were rather varied with a distinct tendency toward conservation. At this time the technic consisted in débridement of the external wound, the wiping away of superficial blood, the excision of necrotic, infiltrated or contused muscle tissue, the removal of splinters of bone, and the closure of the pleural wound by the interposition of muscle covered with skin.

In these earlier operations no attempt was made to repair or to débride the tract in the lung tissue or to remove the foreign body by a well-planned technic. It was soon apparent, however, that a small percentage of these cases died of shock or hemorrhage while the majority died of infection. Every case so treated was a potential empyema or pleuro-pulmonary infection.

The third period embraced a period of active or radical surgery in that practically all cases, except those with small foreign bodies or perforating chest cases with small orifice of entrance or exit and such few cases as were doing comparatively well with closed wounds and slight dyspnoea, were submitted to operation.

An analysis of the postmortem findings in a series of cases dying as a result of wounds of the chest reveals that in those dying within the first forty-eight hours the cause of death was anatomical, namely, shock, mediastinal flutter, combined injuries to diaphragm and abdomen, or multiple wounds. In those cases dying after forty-eight hours the cause of death was due to sepsis. Ninety-six per cent of deaths in injuries of the chest are due to sepsis (Henry and Elliott). This septic death-rate of 96 per cent is remarkable when contrasted with the normal or average septic death-rate of 26 per cent in an active mobile hospital. Occasionally the septic death-rate may reach 33 to 35 per cent. The bacteria involved in the high septic death-rate of chest cases are Gas-producing organisms, 48 per cent, streptococci, 40 per cent, and lung organisms, 12 per cent. In 500 cases of hæmothorax the routine specimens aspirated from the chest demonstrated that 195 cases were infected and of these 87 were infected with anaërobic organisms.

Except for the deaths occurring within a few hours after the injury from shock and loss of blood, the fatal issue of modern chest wounds was almost always due to sepsis in one form or another.

The one outstanding problem before surgeons in this war in wounds of the thorax was the prevention and checking of infection which is carried into the wound in the large proportion of cases.

All wounds of the chest are potentially infected. Modern surgery, however, was able to obviate, inhibit or prevent infection if the surgeon was able to operate during the golden period of operability—the first eight hours, preferably four, between the receipt of injury representing contamination, and the development of infection which ordinarily became apparent about the eighth hour.

The ideal operation contemplated (1) Débridement of all soft tissue about the orifice of entry or exit, particularly all portions of contused, necrotic, or infiltrated tissue in or about the area of the wound, (2) the regularization of all bone ends, (3) complete esquilectomy or the removal of all bone fragments, particularly the in-driven spicules of bone in the lung or pleural cavity, (4) the removal of the foreign body, unless smaller than the nail of the little finger, (5) a debridement of the tract in the lungs and if badly infiltrated or lacerated resection—partial or complete lobectomy, (6) adequate surgical and anatomical repair of the lung by suture, (7) complete toilette of the pleural cavity, removal of blood, foreign bodies, fragments of bone, portions of clothing, etc., many times lying free within the costo-phrenic sinus or impinging upon the opposite chest wall, (8) the repair of the diaphragm and such intra-abdominal exploration as would seem indicated, (9) the hermetical closure of the wound in the chest wall by any of the accepted methods

Classification of Wounds of the Thorax—A satisfactory classification of war wounds of the thorax could be arranged as follows

- 1 Perforating wounds, through-and-through, due to bullet
- 2 Perforating wounds, through-and-through, due to shell fragment
- 3 Penetrating wounds, with retention of large foreign body
- 4 Penetrating wounds, with retention of small foreign body
- 5 Tangential wounds
- 6 Cave-in, stove-in, or crushed-in chest
- 7 Sucking wound or open thorax
- 8 Combined abdominal or multiple wounds

In my own experience there were operatively proved injury to the chest, 51 cases, gunshot wounds, 40, with 15 deaths, bullet, 4, with 1 death, undetermined, 7, with 2 deaths. The types of injury were perforating, 23, penetrating, 17, tangential, 2, cave-in, 2, thoraco-abdominal, 7

Total mortality, 18

Mortality by type of injury—tangential wounds, 2, no deaths, perforating wounds, 23, 6 deaths, penetrating wounds, 17, 6 deaths, cave-in, 2, 1 death, thoraco-abdominal wounds, 7, 5 deaths, admitted in pronounced shock, 19, with 8 deaths, admitted with sucking wounds, 15, with 11 deaths, hæmothorax, 28, with 12 deaths, hæmopneumothorax, 5, with 2 deaths, the ribs were fractured in 18, with 8 deaths, the scapula 6 times, with 4 deaths

The average duration between injury and arrival at hospital was nineteen hours, the earliest time four hours, and the longest time ninety-six hours

The immediate mechanical and anatomical effect of a war wound of the chest is a sudden blow to the chest wall with penetration and in about a third of the cases with fracture of a rib. The projectile courses on through the lung or drives bone fragments before it, the bone fragments constituting secondary projectiles and adding considerably to the laceration of the lung tissue. These fragments or spicules of bone are

very frequently dispersed over a considerable distance around the trajet of the missile and increase the hemorrhage and aggravate the subsequent infiltration and contusion. In many cases the missile passes out through to the opposite wall, and if it succeeds in making its exit does so with eversion or bursting out of the wound of exit. I have never found a bullet imbedded in lung tissue but have found it arrested by the ribs or soft tissue of the opposite chest wall or lying free in the pleural cavity. Very soon the immediate portion of the injured lung about the trajet collapses and is submerged in blood or floating free about the hæmothorax, while the upper portion may show emphysema with skodiatic phenomena. The most dangerous element in the mechanism of this injury is due to the secondary injury from bone fragments which are often projected at considerable distances from the wound and the infectious material carried far into the tissue by the foreign body.

Surgical Indications.—A summary of the surgical indications for operative intervention could be tabulated as follows

- 1 The closure of sucking wounds of the chest wall irrespective as to the retained foreign body or the mechanism of production of the injury
- 2 Continued bleeding or unusual hemorrhage
- 3 Grossly infected, contused or contaminated wounds of the soft tissues. This variety eliminated the cases with a clean-cut rifle bullet wound or the penetrating type of wound due to small shell fragment
- 4 Wounds with fracture of the ribs, clavicle, scapula or vertebra, complicating the original or primary injury
- 5 The retention of foreign bodies other than small éclat. By small we mean a shell fragment certainly not larger than the nail of the little finger
- 6 The onset of a progressive hæmopneumothorax
- 7 Stove-in or crushed-in chest with multiple fractures of many ribs whereby the bone ends protrude into the pleural cavity, bringing about a laceration of the lungs

Clinical Aspects.—Turning now to the clinical phase it is quite obvious that war injuries to the thorax comprise those that die immediately on the field, those who are able to be brought to a regimental aid post, and those capable of sustaining a trip to a forward operation formation. Those that are evacuated from a regimental aid post comprise approximately 4 per cent of the battle casualties received in the forward operating theatre.

In one week in the Marne in the latter part of July we received six chest cases out of sixty wounded. In the Marne the first week in August twelve out of fifty-two cases, while in September at the St. Mihiel sector thirteen out of ninety-four operative cases, the relative frequency of chest cases depending entirely upon the proximity to the battle line.

According to Bissell, 90 per cent of the deaths from wounds of the thorax that occur on the battlefield are due to shell fragments that have

penetrated or entered the thorax over an area corresponding roughly to two closed fists front and behind. It is rare for injuries to the heart and large vessels to reach an operating theatre by reason of the rapid onset of death.

I have operated upon three cases of injuries to the pericardium and one to the heart in an operative experience of about 1600 cases, but have never had a personal case of bayonet wound of the chest. Presumably they all died on the battlefield.

The consensus of opinion among the surgical teams of the American service was that 50 per cent mortality at the field ambulance or mobile hospital was a normal battle casualty mortality for gunshot wounds involving the chest, lungs, pleura or diaphragm.

Hæmoptysis occurred as initial symptom in 25 per cent of cases and was present in about 75 per cent of all histories, sometimes occurring on the second or third day. In perforating wounds of the chest it soon lost its bright bloody character and became streaky. (Six per cent of thoracic wounds were complicated by injury to the vertebral column and spinal cord.)

Hæmothorax occurred in three types: (1) Massive (1500–2500 c.c.) with collapse of the lung, the blood reaching sometimes to the level of the clavicle, (2) moderate (1000–1500 c.c.) with the lung floating on top and compressed and retracted against the chest wall, (3) minor degrees (500 c.c. or less). When the amount of effusion in the hæmothorax reaches about two litres there is an entire collapse of the lung which tends to retract and rest against the vertebral column and is usually free from any adhesions.

Hæmopneumothorax may be classified as exogenous, when it occurs from an open wound in the chest wall, representing the so-called sucking wound, and endogenous when produced through direct injury to the lung tissue. The development of free gas from the growth of anaerobes within the pleural sac is a more common cause in this condition—pneumothorax—than is leakage of air into the pleural cavity. Odor to the fluid from the pleural cavity is one of the most certain indices as to infection—a foul odor as the result of infection with anaerobes together with a buff-colored deposit showing the addition of pus cells to the blood fluid.

The complication of fracture of the ribs with an injury to the lung is one of the most dangerous types of war wounds of the thorax, for in addition to the projectile there are numerous bone splinters driven into the lung. This is particularly noticeable in injuries involving the flat surface of the scapula. In a case at Evacuation Hospital No. 4, at Congy, innumerable bone splinters were found within the lung at varying depths up to 11 cm., and a few closely attached to the projectile itself. The removal of these bone fragments or esquilles is one of the cardinal principles of technic.

In the first twenty-four hours movement of the mediastinum to and

fro is particularly dangerous by reason of the shock produced. At the end of twenty-four to forty-eight hours there is an exudation and infiltration with fixation of the mediastinal pleura. This renders the opening of the chest after forty-eight hours a matter of much less danger than opening a freshly wounded chest.

In open wounds of the chest there is no fluid to splint the lung as in the closed cases, and there is distinct disadvantage in waiting. Under plugging and rest, or as an emergency procedure, the drawing of skin together with silkworm sutures at the regimental aid post, mediastinal flutter is prevented and these patients recover from most of their symptoms.

Traction with a Collin lung forceps upon the injured lung will tend to diminish mediastinal movement, as will placing the patient in a recumbent position with the shoulders elevated and the injured side most dependent. The lung being grasped, it requires very little traction to stop mediastinal movement and the lung may be held in place with a transfixion suture. In the early days of the war—1916-1917—the lung was sutured to the parietal pleura. This we believe to be a faulty practice, for in the condition of partial collapse of the lung or upon traction of the lung to the parietal pleura it is impossible to obtain a normal anatomical relocation of the lung to the chest wall as it existed under natural conditions. The withdrawal of lung into the opening of the wound as recommended by Lihenthal and transfixing it with a pin has not been performed by me but would seem to suggest itself as a very good procedure.

All of the surgery performed was done without the aid of any apparatus or special equipment. In only a few of the cases were we able to obtain nitrous oxide or oxygen anæsthesia. The expansion of the lung by nitrous oxide or oxygen is particularly valuable during the placing of the last pleural closure sutures. The escape of nitrous oxide or oxygen gas into an air-tight mask will forcibly expand the lung until it occupies the entire pleural cavity. When this is accomplished the pleura is hermetically sealed by suture.

Fatalities—In reviewing the causes of death from war wounds of the chest it was found that fatalities occurred in four groups: (1) The unoperated dead—the cases where death occurred a few hours after admission and being due to multiple injuries, hemorrhage or shock. Many of these cases left the regimental aid post alive, but arrived at the hospital dead in the ambulance. (2) The immediate operated dead—the cases that died upon the operating table or immediately thereafter. There is a condition of the wounded soldier which is lethal and beyond which he can sustain no further loss of blood and certainly no surgical procedure, and if operation is attempted in this type all methods of resuscitation fail to save him, whereas blood transfusion before operation will prepare him for an ordinary operative undertaking. (3) The later operative dead, where death occurs at the end of the second or third day of sepsis. (4) The unoperated cases which died as the result of infective hæmo-

thorax—five or six days later—and who occasionally had a late thoracotomy performed as an emergency or drainage operation

Technical Procedures—Choice of Route—The operative approach varied with the type of injury and its location. Where adequate exposure could be obtained through either the orifice of entry or exit intrapleural procedures were carried out through this wound. If the wound was in a suitable position four to six inches of rib were removed subperiosteally, the rib space spread by means of a rib spreader, the pleural cavity carefully cleansed of all blood, the hand inserted and the immediate subadjacent lung delivered into the wound. In every case the attempt was made to remove the foreign body unless it were smaller than the nail of the little finger. In every case the laceration and tract in the lung was cleansed and closed. The mechanical cleansing of the tract was oftentimes incomplete, but it was early established that the lung tissue itself, by reason of its peculiar vascularity, was quite able to take care of a considerable degree of infection. As evidence pointing to this contention one recalls the extreme rarity of gas gangrene of the lung tissue itself. The handling of the lung was not associated with marked fall in blood pressure and was not associated with the same degree of shock as would be induced by similar manipulations of the intestines.

In wounds in the scapular region perforating high up between the vertebral column and the scapula it was rather difficult to obtain adequate access to the pleural cavity. Trephining the scapula proved a very unsatisfactory procedure and excision a needless loss of bone substance. It was much better to divide the rhomboid muscles, the serratus magnus and the latissimus dorsi at the lower angle of the scapula and throw the scapula upwards and outwards. If the nature of the wound would permit resection of the fourth or fifth rib was carried out from the midscapular line upwards to the posterior axillary line. This approach permitted free entry into the chest and allowed the hand to be inserted and the lung delivered. It was better not to advance the anterior incision to the costal cartilage, as the cut end of the cartilage made it difficult to close the pleural cavity at this point. If the wound involved the chest wall at the bottom of the axillary space it almost uniformly perforated the diaphragm and injured the abdominal viscera. It was surprising to note how many times there were wounds of the abdominal viscera without any injury to the lung. On the right side we encountered gross injuries to the liver and kidney, and on the left laceration and injury to the spleen and stomach. In this type of injury an intercostal thoracotomy was done from the midscapular line to the anterior axillary line in the eighth intercostal space, through this aperture it was comparatively easy to repair wounds of the diaphragm and to carry out quite extensive work on the abdominal viscera when necessary. Through this incision the lower portion of the lung can be delivered and partial lobectomy performed if necessary. Total lobectomy has never been necessary in our

hands, but partial lobectomy was done four times. The incised surface of the lung was approximated with a lock-stitch for hemorrhage. We have never had trouble with open bronchus and have never given particular attention to the same, so far as we could judge, it being sufficient to have a lock-stitch for hemorrhage with possibly an approximation suture for the visceral pleura.

Where an injury was low down with compound comminuted fracture of the sixth, seventh, or eighth rib in the midaxillary region, then the incision was enlarged by resecting the seventh rib. Through such an incision the pericardium was sutured twice and in another case a large transdiaphragmatic hernia was replaced with ease. When the diaphragm was injured well out in the costo-phrenic sinus the central portion was occasionally sutured to the parietal pleura. This technic was only employed in combined thoraco-abdominal cases, and where it was essential to close the pleural cavity and at the same time insert gauze into the renal fossa or into the liver. Rarely a loss of substance of the diaphragm could more easily be repaired by suturing the lacerated edge to the parietal pleura than by closure of the defect.

In about one-third of the cases it was possible to get sufficient lung tissue through either the orifice of entry or exit to remove the foreign body and to repair the damaged lung. It was not infrequent to find that the foreign body after having traversed one of the chest walls and a lobe of the lung would be arrested by the opposite chest wall and drop free into the costo-phrenic sinus. In the case of shell fragment the velocity not being very great the fragments ricochete from the far wall of the chest and drop down into the costo-phrenic sinus.

Hæmothorax—The question as to what should be the surgical procedure in the cases of simple hæmothorax due to gunshot wounds was among the most difficult that we were called upon to decide. Aspiration of the contents of a simple hæmothorax did not always show bacteria, but many cases went on and developed fulminating sepsis.

It was found that aspirations taken at different levels gave different bacterial findings. It was considered that about 65 per cent of all injuries to the chest if left alone or simply had the external wound debrided would develop an empyema. Whether these cases were to be operated upon or left alone was a matter largely of individual judgment. Some of the factors which influenced the surgeon were as follows: (1) A hæmothorax due to bullet: the wounds of entrance and exit are small and clean and the damage consisted of a moderate hæmothorax of about 500 c c of blood. Of this type about 25 per cent will become infected and of the infected cases 50 per cent will die, and the remaining 50 per cent will have a long period of pleural suppuration and a third of them will be permanently disabled.

As an example of another type of wound a little bit more severe is a case of a soldier with a through-and-through wound from a shell fragment

with mildly infected wound of entrance and exit and a moderate hæmothorax of about 500 c c , 50 per cent of such cases will become infected and half of these will die under ordinary circumstances, and the remaining half infected will have a prolonged period of suppuration and a third of them are permanently disabled

I was personally unable to formulate any definite indications for surgical intervention in these restricted types of chest injuries. The condition of the patient, the interval since injury, the absence of marked pain (pain out of proportion to the observed wound usually indicated in-driven bone fragments), the absence of continued hæmoptysis or cough, and the absence of dyspnœa and cyanosis were sufficient reasons for treating the cases expectantly and, unfortunately, all too frequently to be regretted.

The cases of infective hæmothorax were profoundly influenced for the better by the introduction of Tuffier tubes and the instillation of Carrel-Dakin solution. A large rubber exit tube was placed in a most dependent portion of the pleural cavity and a number of 4, 5, or 6 Carrel-Dakin tubes inserted into various parts of the pleural cavity. Through these tubes an ounce to two ounces of Carrel-Dakin solution was introduced every two to four hours, the excess of fluid being drained off through the large exit tube. The interstices between the Carrel tubes were lightly packed with gauze. This was our procedure in cases that had not been primarily operated upon when brought into the hospital but who later needed a thoracotomy for infection.

A rather interesting observation was made that after the Carrel-Dakin fluid had been employed for four or five days the discharge was considerably blood stained, upon stopping the instillation of Carrel-Dakin for forty-eight hours this usually cleared up.

The post-operative treatment consisted in placing the patient in a sitting position with the injured lung somewhat dependent. Dyspnœa, cough, and pain were controlled with morphine (gr $\frac{1}{4}$ to gr $\frac{1}{2}$) every four hours until the patient was distinctly narcotized. These cases had an extremely stormy time for two or three days after operation, the temperature was markedly elevated (102° – 104°) with considerable frequency of pulse and in many cases marked dyspnœa.

The operative deaths that resulted usually occurred shortly after operation, and if the patient survived the first twenty-four hours it was a reasonable expectation that he would pull through to such a condition of well-being as to render evacuation to the rear safe.

GUNSHOT WOUNDS OF THE CHEST

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AT the beginning of the war, the expectant principle of treating chest wounds was followed for small through-and-through punctured wounds produced by rifle or machine-gun bullets. This did very well, but a more active plan was essential for the so-called "stove-in chest" with retained foreign bodies, wounds, for the most part, produced by high explosive shell fragments. Active treatment of chest wounds was started by the English and French surgeons in 1916, following the battle of the Somme, and consisted in the excision of the wound, complete cleansing of the pleural cavity, removal of the foreign body, when possible, and primary suture. From the similarity of lung and pleura wounds to other wounds of war, it will readily be seen that the same surgical treatment should apply.

In a series of gunshot wounds classified according to the anatomical region involved, our records show that wounds of the thorax (139) constituted 86 per cent. Of these 118 involved the chest wall. Twenty-one were intrathoracic wounds. There were no wounds of the heart seen. Penetrating wounds of the lung and pleura (21) composed 17 per cent of our gunshot wounds of the chest.

The cases that reached this hospital had already received treatment, and the work here consisted principally in having all chest cases X-rayed and in watching them carefully for complications. As soon as a case came into the hospital, cultures were taken from the surface of the wound and from the wound cavity. The subsequent treatment depended upon the clinical and laboratory reports. The X-rays taken at the front did not always coincide with those obtained at the base. Fluid from the pleural cavity was subjected to microscopic and bacteriologic examination. At times the only guide to infection was the temperature and pulse.

There was a certain number of cases showing severe injuries to the chest wall, and this type required careful X-ray examination to determine the presence of foreign bodies.

In these cases in which there had been penetration of the lung substance with retention of the foreign body, an interesting series of cases developed. These cases bring up the question of what final disposition is made of the retained foreign body in the lung. The general opinion seems to be that a retained foreign body wherever situated will sooner or later give rise to trouble. It is possible for a foreign body in the lung

to become encapsulated, it may be a nidus of infection or it may eventually project itself into the pleural cavity. There are cases reported in which the foreign body was coughed up with a spontaneous cure. Early removal is the best plan, however, when possible. If not removed early and an empyema develops, it cannot then be removed with safety, unless easily accessible, until a later period.

A case illustrating this is shown in a German prisoner of war received at this hospital on October 15, 1918. He was wounded October 9, at 8 A M, and was dressed after his capture on the field two hours later. He was removed in an ambulance, but the car was wrecked by shell fire and the patient crawled into a dugout. He received no attention for three days, and was without food for this time. He was admitted to this hospital on the 15th, and as we had no X-ray equipment at the time no picture was taken. The operation consisted in the removal of the broken ribs and bone fragments with the evacuation of large quantities of pus from the pleural cavity. Rubber-tube drainage was inserted. Cultures of the fluid showed staphylococcus, Gram-positive and Gram-negative cocci. Later an X-ray of his chest was obtained which showed a foreign body $2\frac{1}{2}$ by 1 cm. Following the operation the patient continued to improve with a gain in weight. The empyema ran the usual course and he was later discharged from the hospital. No attempts were made to remove the foreign body. The above case shows the extraordinary resistance the lung has to a foreign body.

Another instance of retained foreign body in the lung was seen in the case of Sergeant C W of the 326th Infantry, aged twenty-two years, who received multiple gunshot wounds of the right forearm, thigh, and top of shoulder. It was through the latter that the missile penetrated the chest. This patient was wounded October 14, 1918, in the Argonne, at 8 P M. At 8 30 he jumped on a moving ambulance and was taken to Field Hospital 328. He remained two hours and was taken to Evacuation Hospital 11. October 15 an operation was performed on the arm and thigh under local anæsthesia. A foreign body was removed from the thigh. X-ray demonstrated a foreign body in the chest. The patient coughed up blood.

He was admitted to Base Hospital 61 October 16, 1918. The X-ray showed a foreign body which moved with respiration in upper right chest. The foreign body had entered the chest through the wound on the top of the right shoulder between the outer end of the right clavicle and the spine of the scapula. He showed the physical signs of a thickened pleura, from the fifth space to the base anteriorly, and the angle of the scapula to the base posteriorly.

This patient also had a partial paralysis of the ulnar and radial nerves, but showed improvement. The wounds healed.

Upon discharge physical examination of the chest was negative. Total expansion was $2\frac{1}{2}$ inches, right side 1 inch, and left side $1\frac{1}{2}$ inches. Heart action at rest was 86, after exercise, 120. Absence of complications in this case is noteworthy.

There are two definite groups of late symptoms in cases of retained foreign bodies of which these cases complain, those having a physical basis and those in which the symptoms are largely nervous. In that class showing nervous symptoms the presence of the foreign body appears at times to cause a certain amount of mental anxiety. The question of operation in these cases for the removal of a foreign body is a difficult one to settle. We must remember that these cases have recovered from a severe injury, and that a thoracic operation can not be considered lightly. In certain selected cases in which the symptoms are very pronounced, and localization shows that the foreign body is easily accessible, a secondary operation is justifiable.

There is a group of hæmothorax cases, for the most part through-and-through wounds, which entered the hospital. These cases were carefully screened and rayed and if infected were drained. The following will illustrate a case in which aspiration sufficed to effect a cure.

M. B., private, Co. R, 165th Infantry, received a through-and-through bullet wound of the right chest. He was wounded in the Argonne on October 13, 1918. He was in the field for an hour and crawled behind a bank at the roadside. He remained there for several hours and then walked three kilometres until picked up by an ambulance. He was driven about six kilometres to a field hospital where he received an injection of anti-tetanic serum. Several hours later he was removed to Evacuation Hospital 16, where he arrived at 2 A. M., October 14. Here he was fluoroscoped and no fluid or foreign body demonstrated. En route to the evacuation hospital he coughed up blood. On October 16 he arrived at Base Hospital 61, and examination revealed a healed wound of entrance in the mid-clavicular line $1\frac{1}{2}$ inches above and somewhat internal to the nipple. A wound of exit was found $2\frac{1}{2}$ inches to the outer side and below the angle of the right scapula. Vocal fremitus was decreased posteriorly on the right side and there was dullness over the same area. Breath and voice sounds were decreased below the angle of the scapula behind. Total expansion was $1\frac{1}{2}$ inches, right $\frac{1}{2}$ inch and left 1 inch. An X-ray picture indicated fluid to the level of the third rib in the axillary line. On aspiration 900 c.c. of bloody fluid was obtained. Culture of this fluid showed Gram-positive diplococci. Another picture, taken November 29, still showed a small amount of fluid at the base of the right chest. On November 3 and 4 the temperature reached 101.4° . At all other times it had been normal. This soldier was later returned to the United States.

As is to be expected, pneumonia and empyema are frequent occurrences. The latter may be the usual post-pneumonic type, or the mode of origin may be directly traced to the infection by the foreign body. It must not be forgotten that an otherwise uninfected hæmothorax may be easily converted into an empyema, either from insertion of a dirty aspirating needle into the chest, or if the needle punctures the lung in an infected

area the chest fluid may become infected upon the withdrawal of the needle. Pathogenesis in these cases may be impossible to determine. This is true of the following case:

Private, Co D, 167th Infantry, aged twenty-four years. Diagnosis: Perforating wound of the right chest. Fracture of the superior angle of the scapula, fracture of the fourth, fifth, sixth, seventh, eighth, and ninth ribs. The patient was wounded on October 14, 1918, and passed through Evacuation Hospital 11 two days later. The wound of entrance was in the right shoulder. He suffered from shock and hæmoptysis. The right chest was aspirated and a pint and a half of bloody fluid removed. Three days later a quart was withdrawn. On October 22 he was admitted to Base Hospital 61. On admission he complained of dyspnoea and thoracic pain. His temperature was 103°. An exploratory puncture was at once made and no fluid was obtained. Examination of the chest showed definite signs of broncho-pneumonia. On October 24 an X-ray showed the right chest markedly opaque. A machine-gun bullet was located in the left side of the chest, on the level with the first lumbar vertebra and a small foreign body in the right chest. The following day 20 cc of sanguinous pus was removed. The aspirations were continued daily until November 1, when a portion of the ninth rib was excised under local anæsthesia and drainage secured with two rubber tubes. A week later special Carrel tubes were placed in the wounds and the right chest was irrigated with Dakin's solution. Smears taken showed Gram-negative diplococci, staphylococci, and streptococci. Under this treatment his general condition improved with a fall in temperature. The patient did not take the irrigations well and they were subsequently discontinued. This was probably due to a communication with a bronchus, as he coughed considerably, which was thought to be due to the chlorine vapor. On December 9 an X-ray plate showed the foreign bodies and an abscess cavity on the right side surrounding the small foreign body. During this time the patient was in such poor condition that it was doubtful whether he would recover. Physical examination showed a machine-gun bullet under the skin on the left side, between the eleventh and twelfth ribs, about 5½ inches from the spine. The patient ran the usual course of an empyema, the machine-gun bullet was removed, the operative wound closed, and the patient subsequently evacuated to the United States.

Small localized empyemas are very likely to be overlooked. Repeated X-ray and physical examinations are necessary to detect them. Sinuses are sometimes misleading, as they are not always connected with a demonstrable foreign body, being at times due to imperfect obliteration of a cavity.

A case of mixed infection, bilateral broncho-pneumonia, following a penetrating gunshot wound of the right chest with subsequent empyema, was seen in the case of Private V A, Co G, 166th Infantry, aged twenty-three years. He was wounded October 14, 1918,

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and admitted to Evacuation Hospital 10 two and a half hours later. On fluoroscopic examination a foreign body (character not mentioned) was located between the ribs. The chest cavity was not entered. Débridement and removal of the foreign body $\frac{1}{4}$ cm long (probably shell fragment) was done. He was admitted to Base hospital 61 October 16, 1918. There was a wound on the right chest between the seventh and eighth ribs anterior to the axillary line. A bilateral broncho-pneumonia developed. The sputum showed Type 2 Pneumococcus. The heart was pushed to the left. Definite signs of fluid. On November 2, 1800 c c of cloudy fluid was withdrawn from the right chest. This, upon examination, showed Gram-positive streptococcus and diplococcus.

On November 4, 300 c c of fluid was again aspirated from the right chest. On November 16 excision of one inch of the eighth rib in the right posterior axillary line was made, and the chest drained. The temperature was subsequently within normal limits. Upon discharge expansion of the right lung was good. Percussion note was somewhat impaired in the lower chest. This patient was sent to the United States.

Pneumothorax of varying degrees is seen as such, but more frequently associated with hæmo- or pyo-thorax. A marked degree of subcutaneous emphysema is rare, but may result, as was noted in the following soldier.

Sergeant W M C, 61st Infantry, M G Co, was admitted to our hospital November 14. He had a penetrating wound of the chest produced by a machine-gun bullet. This patient was wounded November 6, and passed through Field Hospital 25 and Mobile Hospital 8. There a machine-gun bullet was located in the muscles of the back and removed. Débridement of the anterior and posterior wounds, with primary closure of both pleura and skin, was done. The day following he developed an extensive subcutaneous emphysema from head to lower abdomen. On November 14, the date of admission to this hospital, he showed, upon examination, two sutured wounds in the chest. One was on the right side below the clavicle and the other at the lower angle of the scapula posteriorly. The sutures were removed and a large amount of pus removed from the posterior wound and a small amount from the anterior. There was a subcutaneous emphysema of chest and abdomen. The scrotum was distended with air to the size of a foetal head. Radiographic findings showed a fracture of the second rib with evidence of thickened pleura. The patient's condition gradually improved so that on December 2 he had only a slight cough and the wounds were healing with slight discharge. On December 8 his sputum was tinged with blood and he complained of pains in the upper right chest. Physical examination showed an area of cavernous breathing in the right mammary region near the sternum, but three days later this had disappeared, leaving a few râles at the bases. At no time did the temperature rise above 100.8°. The average temperature was 99.4°. On

December 16 the breathing and expansion of the right chest was good with slight increased sounds over the lower chest. The patient was transferred to the United States a few days later, perfectly well.

In the series of penetrating gunshot wounds of the lung and pleura there were five deaths. The mortality was about 23 per cent. The autopsy protocols of these cases are appended.

The preceding record presents two main points for discussion, (1) the treatment of retained intrathoracic foreign bodies, (2) hæmothorax. In general the proper procedure to apply in the first is governed by the principles which apply to foreign bodies retained elsewhere in the body, *i e*, if they are the cause of symptoms they should be removed.

As regards the treatment of the second condition, if infected, these cases should be opened and drained as in empyema.

Combier and Hertz practiced extraction of missiles only in cases that seemed likely to be poorly tolerated or especially likely to reinfect the wound. They were influenced by the fact that the removal of intrapulmonary projectiles was less grave in its consequences when the inflammatory process had subsided. Although they rarely practiced primary extraction in cases of infected pleuræ, yet they were forced to undertake it in five cases. In five other cases the projectile was removed in the course of thoracotomy for pleural suppuration. In searching for foreign bodies the rib-spreader of Tuffier helps greatly.

Pehu and Daguet, in a paper upon the late results of gunshot wounds of the chest, found that 27 of 146 cases under examination were bearers of intrathoracic projectiles. These were apparently well tolerated and around them could be seen no modification of the radiosopic image. These writers believe that the clinical signs are of much less importance than those signs revealed by X-ray examination.

Olivier, in a study of thirty cases of gunshot wounds of the chest in which projectiles were retained in the lung, subjected fifteen to operation. The small size of the foreign body and the absence of symptoms contraindicated intervention in some cases. In others patients refused to subject themselves to operation, believing that they were doing sufficiently well. Of the fifteen who accepted operation, some did so because of the anxiety which the projectiles, imbedded in their chests, seemed to cause. Two of Olivier's cases are worthy of note. In one hemorrhages were brought on by a slight effort. In another, in addition to repeated severe hemorrhages, there was a constant expectoration of foul pus. In both the general health was seriously affected. The first case was subjected to operation with cessation of the hæmoptysis. The second case declined operation.

One may often be surprised in operating upon these cases at the very slight extent of the pulmonary lesions. A varying degree of adhesions are usually present. The projectile is very frequently surrounded by a thin sack, well limited, and immediately outside this the area of pulmonary tissue becomes healthy. On the other hand, a condition quite different may be encountered if the foreign body is the cause of symp-

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toms There may be an intense local reaction, the sack being less clearly limited Sometimes an abscess is found surrounding the foreign body

A retained projectile may easily become the cause of abscess of the lung or pulmonary gangrene

The history of surgery of the lung has been dominated by the fear of pneumothorax That little danger attaches to this has been demonstrated by the experience of Duval and others, who, in their search for projectiles, have performed wide thoracotomy

When a sufficiently long period has elapsed between the infection of the wound and operation, mortality will be slight Thus, Marion, in one hundred and fifty cases, had but one death The final results apparently warrant its practice in those cases in which projectiles produced symptoms of pulmonary reaction, hemorrhages, and purulent expectoration Cases which have been operated upon and examined five months later presented a functional condition identical with, or less satisfactory than, that which had preceded operation, excepting in those cases in which hæmoptysis and purulent expectoration had been present

Colonel G E Gask, D S O, Consulting Surgeon to the British Expeditionary Forces in France, agrees that all large missiles (by this is meant a shell fragment about 1 by $\frac{1}{2}$ inch) should be removed at an early date, namely, during the first two or three days after injury

According to Duval, the mortality of wounds of the lung from portions of the shell with retention of the missile is 28 per cent Duval was an early advocate, beginning with personal experiences following the battle of the Somme in 1916, of treating all wounds of the lung by excision of the wound, complete cleansing of the pleural cavity, excision of the parietal wound, and primary suture of the chest He is of the belief that every wound of the lung which, on fluoroscopic examination, shows a large intrapulmonary hæmatoma should be operated upon, because it almost invariably becomes infected According to his latest statistics for operations not urgent he has operated upon but eighteen cases out of one hundred and eighteen He considers the favorable time for operation on the lung as soon as possible after the injury, and after thirty hours it is, as a rule, not advisable to perform any operation

Prior to 1916, in a series of three thousand cases, excluding a large number of deaths which occurred in the very advance posts and in base hospitals, the general mortality in evacuation hospitals and advanced dressing stations reached 30 per cent The predominating causes of death were hemorrhage, mechanical disturbances of respiration from open thorax and, above all, infection of the lung and pleura

The serious complication of chest wounds, then, is infection of the pleural cavity These wounds are contaminated with the same germs that infect other war wounds A very rapid traumatic gangrenous pleurisy, which kills in forty-eight to seventy-two hours, is probably due to organisms carried by the projectile itself It must not be forgotten,

however, that streptococci, as well as those organisms which are the normal inhabitants of the bronchial tree, are also present

If a foreign body is present in the chest the surgeon himself should verify localization. This is more important in the parietes than in the lung. It is desirable to know the presence and extent of adhesions. Major G. Grey Turner, R. A. M. C., employed a simple plan which has proved useful. A straight needle 3 inches long is thrust into the lung and its excursion noted. If there are no adhesions present the needle follows an up and down course a distance of $\frac{1}{2}$ to 1 inch with each respiration. Depending upon the extent of adhesions the excursion of the needle will be seen to be absent or much limited. Turner advises operation in penetrating wounds with retained foreign bodies in the pleura or lung, if there are definite irritative symptoms leading to disability or continued discomfort, and in those cases in which the removal of the foreign body would rid the patient of anxiety preying detrimentally upon his mind. He hesitates to operate when localization shows the foreign body in or near the hilus.

As regards the treatment of hæmothorax, we should content ourselves with aspirating as completely as possible and make every effort to detect early signs of infection at the earliest possible moment by repeated bacteriologic examination. Infection having developed, the chest should be emptied of all blood and clots by excision of an inch of rib and insertion of a tube. It is believed to be better surgery if operation is performed within a few days after injury to do a wide thoracotomy, cleanse the pleural cavity, and close the chest, keeping the pleural cavity subsequently dry, if necessary, by repeated aspiration. In this way the chest may remain closed, the lung is allowed to expand, and respiratory distress is lessened. If, however, the infection persists, the wound may be reopened and the tube inserted. We may summarize the indications for operation in gunshot wounds of the chest as follows:

- 1 Foreign bodies in the parietes, with or without sinuses
- 2 Foreign bodies in the lung, irrespective of size, if associated with persistent cough, hemorrhage, or suppuration
- 3 Large foreign bodies in the lung, even if the symptoms are purely nervous
- 4 All foreign bodies in the pleura, with or without empyema
- 5 All cases of infected hæmothorax
- 6 All cases of through-and-through wounds with shrinking of the side, lessened lung expansion, and interference with movements of the diaphragm in which treatment by exercise, et cætera, has failed

AUTOPSY RECORDS OF GUNSHOT WOUNDS OF THE CHEST

CASE I—Private P. P., No. 2981368, Co. M, 7th Infantry, aged twenty-three years

Wounded October 11, 1918. Multiple gunshot wounds. Extensive pneumothorax of the right chest with emphysema of the sub-

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cutaneous tissues Disappearance of liver dullness Apex beat two fingers to left of nipple line Aspiration of pleural cavity showed a large quantity of foul-smelling yellow fluid and defibrinated blood Death Autopsy

The wound of entrance was about two inches below the clavicle, slightly outside the nipple line, between the first and second ribs The bullet had fractured the second rib, passed through the upper and middle lobe of the lung, passed downwards and backwards, leaving the thorax in the mid-axillary line It fractured the eighth and ninth ribs and, passing through the skin between the tenth and eleventh ribs, it reentered the buttock slightly posterior to the anterior superior spine of the ilium Empyema of the right thorax Traumatic diaphragmatic hernia containing 6 to 8 inches of the proximal end of the transverse colon Pericarditis by extension Slight laceration of the liver Collapse of the right lung

Postmortem examination showed an under-nourished individual On opening the abdomen the hepatic angle of the colon could not be located and was later shown to have become herniated through the diaphragm The pleural cavity contained about 200 c c of yellow-green, putrid pus The right lung was collapsed and on section contained no air It was covered with a thick, greenish-gray exudate The bullet had traversed the anterior part of the upper lobe The posterior surface of the right lower lobe had been slightly lacerated by spicules of bone from the rib About 8 inches of colon were found in the right thorax, protruding through a rent in the diaphragm

Upon opening the pericardium there was a slight increase in the amount of fluid and a fibrinous deposit on the mesial side of the parietal pericardium This had extended from the pleura The stomach and intestines were normally placed with the exception of the hepatic flexure of the colon, as noted above There apparently had been no obstruction of the bowels

The upper part of the right lobe of the liver had been slightly injured by the passage of the bullet through the diaphragm The gall-bladder, genito-urinary system, pancreas, thyroid, adrenals, and brain were normal

CASE II—Private J V H, No 1757896, Co D, 312th Infantry, aged twenty-five years

Wounded October 18, 1918, when he received a gunshot wound which penetrated the left lung He entered Base Hospital 61 October 19 The wound of entrance was above the spine of the scapula posteriorly, and the wound of exit in the second interspace in the mid-clavical line Râles were heard over the left lobe, posteriorly Pneumothorax Dullness over the right lower lobe Fluid in the right pleural cavity Symptoms of meningitis Death Autopsy

Anatomical diagnosis Acute purulent meningitis due to Gram-negative diplococcus Fracture of the first and second ribs, penetrating bullet wound of the right chest Subscapular abscess connected with a localized empyema at the apex of the right pleural

cavity Hæmothorax Atelectasis of the right lower lobe Sub-acute parenchymatous nephritis Chronic endocarditis of the mitral valve, with stenosis Acute cholecystitis

The right lung was very firmly adherent to the base There was a large, bulging mass at the apex, about the size of a man's fist The lung was firmly adherent to this This mass was opened and was found to be filled with pus The left lung was free and no fluid was present The bronchi were intensely congested and contained some pus On section, the right upper lobe of the lung contained many consolidated lobules This appeared to originate by extension from above Right lower lobe was very small and collapsed and contained no air The left lung contained air throughout The mediastinum contained large, swollen lymph-glands and showed considerable œdema

Circulatory system The valves were free and soft except the mitral, which showed a distinct vegetation, causing stenosis There were yellow, elevated nodules on the aorta around the openings of the intercostal vessels

On section the kidney capsule stripped with considerable difficulty The surface was torn They cut less easily than normal, apparently due to an increase in connective tissue There was a considerable plastic exudate around the gall-bladder It was adherent to the duodenum The pancreas, the adrenals, the liver, thyroid and the bones and the gastro-intestinal systems were normal

Upon examination of the brain there was a slight exudate along the course of all the vessels, especially in the Sylvian fissure and on the inferior portion of the cerebellum

The course of the bullet was traced from the supraspinous fossa on the right side of the posterior chest, passing through the chest wall and fracturing the first and second ribs on the left side There was a marked infection along the course of this tract The large pus pocket at the apex of the right lung was connected with another large pus pocket in front of the right scapula Infection had extended to the periosteum of the spinal column and apparently affected the central nervous system by direct extension

Bacteriology Cultures from the heart blood showed no growth From the abscess at the apex of the lung streptococcus and pneumococcus Smears from the brain showed a Gram-negative diplococcus

CASE III—Private E B C, Co I, 308th Infantry, aged twenty-four years

Lacerated gunshot wound of the right chest Empyema Collapse of the right lung Infraction of the spleen Death Autopsy

Admitted to Base Hospital 61 October 7, 1918 Wound of the right chest penetrating at the fifth interspace in the anterior axillary line

This extended from the nipple to the costal margin A counter opening was seen at the eighth interspace in the posterior axillary line

Much mucus in the left bronchus The right lung had collapsed

GUNSHOT WOUNDS OF THE CHEST

completely and was firmly adherent to the diaphragm and mediastinum. This was firm and contained no air and was beef-red in appearance. The pleural cavities were covered with a thick, yellow, fibrinous exudate. There was a large communication with the exterior, admitting two fingers easily through the fourth and fifth interspaces. The fifth rib had been broken and partly removed. The bullet left the chest about the eighth interspace. The circulatory system, gastro-intestinal system, genito-urinary system, liver, thyroid, adrenals, and brain were normal. The spleen was one and one-half times its normal size. The capsule was not thickened and on section was very soft and congested.

CASE IV—Private D C J, aged twenty-five years, Co C, 324th Machine Gun Battalion

Wounded November 10, 1918. Bullet penetrated the soft parts of the left upper arm, entered the left chest below the axilla. Admitted to Base Hospital 61 November 14. Wounds dressed and drainage tubes inserted. His general condition was poor. Temperature, 104°. Dullness of the left lobe. Aspiration in the sixth interspace. Much foul-smelling gas removed. Wound culture showed an anaerobe. November 24, patient delirious, in extremis. Died the following day.

Anatomic diagnosis. Empyema. Collapse of the left lung. Broncho-pneumonia. Fracture of the left fourth rib. Gunshot wounds multiple, penetrating left chest. Retained foreign body.

There was a penetrating wound on the external surface of the left arm, which passed posteriorly to the humerus. There was a ragged, superficial wound on the lateral surface of the thorax in the left mid-axillary line at the level of the fourth rib.

The left pleural cavity contained about 600 c c of frothy, foul-smelling pus. The lung had collapsed and was firmly adherent to the mediastinum and diaphragm. The lower end of the trachea and bronchi were very congested and contained considerable sero-sanguinous material. The left lung was covered with a thick, black exudate. The lateral surface, half way between the base and the apex, was lacerated. The terminal bronchioles were much dilated. The middle lobe was the same as the upper and there were some dark, depressed alveolar outlines. Many were consolidated along the inferior and posterior surfaces. These areas were dark red, stood out distinctly from the surrounding air-containing tissue, and sank rapidly in water.

Circulatory system, gastro-intestinal system, and genito-urinary system normal.

The liver was about one and one-half times its normal size, enlargement chiefly confined to the left lobe. The surface was very mottled, with yellow edges, and on section this presented a distinct nutmeg appearance. Other organs normal.

Bacteriology. Heart's blood showed a non-hæmolytic streptococcus. From the lung was obtained a Gram-negative, motile, putrefactive bacillus (undetermined), staphylococcus and streptococcus.

CASE V—Corporal A W, No 735837, aged twenty-two years, Co F 11th Infantry

Wounded November 5, 1918, at 6 A M Diagnosis Gunshot wound of the left lower chest and upper abdomen At operation eight hours later, the upper abdomen was found filled with blood The pleural cavity was cleansed and the lacerated spleen removed No evidence of injury to the intestines Closure of the abdominal wound with rubber-tube drainage Intravenous saline Patient in poor condition November 12 a large amount of sloughing tissue was removed

November 14 he was admitted to Base Hospital 61 The sutures had pulled out and the entire wound was open for a distance of 8 inches Cultures from the wound showed streptococcus and an anaërobe November 19 the wound was partially drawn together with heavy through-and-through silk sutures November 24 signs of a right broncho-pneumonia

Gunshot wound of the chest in the mid-scapular line, fracturing the eleventh rib Wound of the abdomen in the left hypochondriac and lumbar region Collapse of the left lung Empyema left, acute fibrinous pleurisy, localized peritonitis, hæmolytic streptococæmia

Postmortem examination showed an emaciated individual A large suppurating wound on the anterior abdominal wall There was a large wound perforating the thorax, through the space occupied by the eleventh rib

The intestines were adherent to the anterior parietal peritoneum Localized peritonitis limited to the intestines subadjacent to the wound Adhesions were easily broken up The spleen had been previously removed There were many adhesions in this region

The left lung had collapsed There was no pus in the pleural cavity, but a thick, fibrinous exudate on the visceral and parietal pleura The right lung was very voluminous and the posterior part of the lower lobe was slightly reddened and showed subpleural hemorrhages On section the upper and lower lobes were air-containing throughout The lower appeared reddish on the surface and on section sero-pus escaped The left lung was about one-third its normal size The parietal pleura was removed with the diaphragm It was very thick and tough, like shoe leather, as was the visceral pleura Both surfaces were covered with much fibrinous exudate The pleural cavity had evidently been the seat of a marked suppurative process, which had drained out completely through the opening of the thorax The lower and posterior parts of the lobe were consolidated The inferior surface was firmly adherent to the diaphragm The genito-urinary system, pancreas, and adrenals were normal The thyroid was much enlarged and gave the appearance of colloid degeneration Some loops of the ileum were adherent to the colon and the abdominal wall There was no ulceration or obstruction The cæcum and transverse colon were evidently involved by direct extension from the wound On section the liver showed some evidence of cloudy swelling

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The surface of the brain was much congested and there was a brown spot 5 cm long and 2 cm wide on the inferior surface of the frontal lobe, involving the extreme anterior portion. This appeared to be the seat of an old hemorrhage.

Bacteriology Heart's blood showed hæmolytic streptococcus, abdominal wound staphylococcus, Gram-negative and Gram-positive diplococcus. From the lung hæmolytic streptococcus and staphylococcus were recovered.

OPERATIVE RESULTS IN TWO HUNDRED BREAST TUMORS *

BY BYRON B DAVIS, M D

OF OMAHA, NEB

My private records of operations for growths of the breast contain the histories of 166 persons suffering from malignant tumors and 44 from benign. In this series no cases have been included that were operated during the last three years, and the records cover my private work from 1898 to December, 1916. The records of many other cases operated are inaccessible or so incomplete as to be valueless. The cases included have practically all of them been verified by the microscope in the hands of a trained pathologist.

Of the 166 cases of malignant disease that an effort has been made to trace there was one operative death, the remaining 165 having left the hospital apparently in good condition. One hundred and sixty-five were diagnosed as carcinoma and only one sarcoma was found. All but one occurred in women.

My letters were sent to the husband, son, daughter, or physician, and not to the patient, as it was felt that this method would most likely bring answers in the event that the patient had died. To the 165 letters sent out answers have been received thus far from 101. Up to the present, 64 have failed to answer and these cannot be used for statistical purposes.

Of the 101 answers received 63 may be considered free of the disease for periods ranging from three to about twenty-one years. Of the 38 remaining 36 have died of local or disseminated cancer, and two yet living are suffering from recurrence. Three or four reported dead were not considered by their relatives to have died of cancer, one was called "creeping paralysis," one "from a stroke," etc., but these were obviously deaths from cancer and are so included.

This gives us, then, the rather encouraging result of a little better than 62 per cent of the cases free of recurrence from three to twenty years. I refrain from using the word "cured" in this connection, for there have been a number of cases that have remained free of any evidence of the disease from five to nine and one-half years and have then recurred and died of the disease, and there is little doubt that some of the cases reported free of all trouble now will later succumb to the disease. For this reason it is freely conceded that 62 per cent is not a fair estimate of cures obtained. It is also only fair to presume that among the 64 not heard from the proportion of deaths is larger. It is only natural that the friends of the living would be more likely to answer the questions propounded than the friends of the dead.

* Read before the Western Surgical Association, Dec 6, 1919

OPERATIVE RESULTS IN BREAST TUMORS

Allowing for all sources of error we have 63 very favorable results, and this means a good many years of life and health and, it is hoped, happiness in the aggregate

Under benign diseases of the breast there have been included 44 cases. Two cases that were considered benign at the first operation later appeared with carcinoma and underwent the radical operation. Whether the diagnosis first made was erroneous or the malignancy was of later development it is impossible to say. Forty of the benign cases were in females and 4 in males. Under the caption adenoma, fibroadenoma, and cystadenoma there were 37, and one with mastitis complicated with adenomata. In 3 of these cases both breasts were involved and the tumors excised from both. In two cases after the adenoma had been excised from one breast it appeared in the other and was excised, and in one case a second adenoma was later excised from the same breast.

The treatment of the adenomata in females was simply excision, usually through an incision along the thoraco-mammary junction, the breast being turned up and the tumor removed from underneath. In two cases of multiple fibroadenoma the disease was so extensive that simple amputation of the breast was done, and in two other cases before I made a regular practice of having a frozen section made immediately in all doubtful cases, I did the radical operation under the impression that it was carcinoma. Later these two cases were shown microscopically to be benign and are so counted. In each of the four male cases the breast was amputated.

In the cases mentioned of mastitis complicated by multiple adenomata the breast was amputated as was also done in three cases of generalized chronic mastitis. There were also two cases of lipoma that were simply enucleated and one case of mammary tuberculosis in which the breast was removed.

The average age of those having benign growths was thirty-four years, while the average age of those suffering from carcinoma was forty-seven and one-half years. The surprisingly large number of women with carcinoma between the ages of thirty-five and forty-five and the small number past sixty brought the average below that usually given.

For some time I have been under the impression that the propaganda being carried on by the "Society for the Control of Cancer" and by the medical profession generally is bringing women with cancer of the breast to the surgeon much earlier than formerly. From this standpoint my statistics are truly disheartening. The time the growth was first noted is given in almost all the histories. The average time between the discovery of the "lump" and the day of the operation in those operated before 1910 was one year, three months, eight days, while those operated during the years 1910 to 1916 were aware of the growth one year, five months, eight days before the operation, a difference in favor of the earlier group of exactly two months. A partial explanation of this apparent lack

of progress is that in the 1910 to 1916 period are included two women with tumors of thirty and fourteen years' standing, respectively. Leaving these two cases out of consideration it would bring the average duration of the later period down to a little below that of the earlier.

Statistics are peculiar things. It is also found that the average time between the discovery of the "lump" and the operation of those that died of recurrence is practically the same as of those that have remained free of the disease. These apparently contradictory figures should not lessen our determination to operate as early as possible in every case. The discovery of the "lump" is in most cases purely accidental, and it bears little relation to the beginning of the disease. Every surgeon frequently operates on tumors only recently discovered that show advancement and must have been well started months before the date of discovery. It is evident that in most cases carcinoma of the breast antedates its discovery weeks and months and sometimes years.

There was one operative death, Mrs. N., of Valentine, Neb., aged seventy years, referred by Dr. Alfred Lewis. Had carcinoma of the right breast, well advanced and of five years' duration. Her condition seemed satisfactory, and the usual radical operation was done October 23, 1912. She died October 25 of suppression of urine.

Another case was a tragedy. Mrs. R., aged sixty-one years, had carcinoma of the right breast with great axillary involvement. She was operated June 21, 1910. In dissecting some adherent glands from the axillary artery the artery was punctured. The wound was sutured as carefully as possible, but at the close of the operation no radial pulse could be felt. The arm was wrapped in cotton and kept as warm as practicable, but gangrene of the forearm occurred, and July 6 the arm was amputated at the junction of the middle with the lower third. She recovered nicely from the operations but died of recurrence of the cancer eleven months later.

For the past eight years it has been the regular procedure to have a pathologist present in all doubtful cases who makes a frozen section of the removed tumor. In from three to eight minutes he is able to make a fairly thorough study of some sections. If he finds a definite picture of malignancy the radical operation is done at once, if he fails to discover malignancy the little wound is closed. This combination of the macroscopic study of the growth and the microscopic examination is fairly free from error, but not as certain as a careful laboratory study of the case made at leisure. To combat this source of error the tumor is taken to the laboratory later and prepared in the usual way and many sections are studied. In two cases of this series that appeared benign at the hasty frozen-section examination, malignant areas were discovered later and radical operation was done.

In this series are many cases that have had local recurrences which have been removed by later operations. It is fair to state that most of

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the cases requiring secondary operations have subsequently died of the disease, but this has not been true of all of them. Even if all of this class had finally died operations for local recurrences prolong life and keep the patient hopeful. Several with one or more recurrences that were promptly removed are still alive and well and free of any evidence of disease a number of years after their last operation. As an example of what may be done Mrs. R., aged forty-six years, was operated for a carcinoma of the right breast of four years' duration, November 22, 1909. A nodule appeared in the scar and was removed by a wide dissection July 28, 1910. Still another recurrence along the line of the scar was removed April 1, 1911, about eighteen months after the first operation. She came to my office a few months later and the scar was nice and smooth and gave no sign of any active process. About this time she moved to Chicago. On October 19, 1919, a letter from her husband stated that she is alive and well and had had no further evidence of the disease since her last operation, eight and one-half years before.

Cases of this kind give one courage to persist in removing these local recurrences when the outlook is darkest. One should make as great an effort to get rid of a recurrence radically as if he were dealing with the primary disease.

Among the 166 cases in this series one woman presented herself with carcinoma of both breasts that had developed simultaneously. Radical operation was done on both sides February 22, 1904. She was alive and well and free of recurrence a year ago, the last time I have heard from her.

In the series were seven patients operated for carcinoma of one breast who subsequently returned with carcinoma of the other for which radical operation was also done. Five of them died subsequently of cancer and two are alive and well six and one-half and seven and one-half years, respectively, after the second breast was removed. When a carcinoma permeates the lymphatics inward to the sternum it may be carried by the anastomosing lymphatics across the front of the sternum to the opposite breast and axillary glands, and really when the permeation pursues this course it is not of much graver significance than to be carried to the lymphatic glands on the side in which it originates.

The youngest case in the series was a girl only eighteen years old. Only a few days before she appeared for an operation a "lump" was discovered in the left breast. It was almost "woodeny" in feel and had all the clinical characteristics of a typical carcinoma. A frozen section from the tumor, removed June 8, 1916, was pronounced by Doctor Manning to be carcinoma and the radical operation was done. The later study of numerous sections confirmed this diagnosis. It was clinically, macroscopically and microscopically an adenocarcinoma. This girl has been lost sight of.

There was in the series one case of sarcoma operated October 16, 1916. Two local recurrences were removed the first six months after the radical

operation A letter from the husband, written October 25, 1919, states that she is in the best of health and there is no sign of the disease

Most of the cases operated the past ten years have received X-ray treatment I am not able to make any positive assertions concerning its effects About all I can say is that it seems a mildly palliative measure, and should be used vigorously after every operation for mammary carcinoma

A few years ago it seemed that the ultimate had been reached in the surgical management of carcinoma of the breast The ideas promulgated by Handley have produced some modifications that promise to lower the final death-rate still more Formerly about all we had in mind was to remove the breast, the pectoral muscles, and fascia widely and to clean out the axilla with the feeling that the avenue of dissemination outside of infiltration and metastasis was *via* the lymphatics leading to the axilla, and sometimes the enemy would make a counter attack on the mediastinum, the lungs, the liver, or some other vulnerable point for which the surgeon did not blame himself because he considered these attacks embolic and involvement of these regions meant metastasis *via* the circulation

It seems that Handley's views that the chief method for the dissemination of cancer is by the cells growing along the lymphatic vessel lumina, and that they can as readily grow downward and penetrate the abdominal wall in the epigastric angle and reach the liver or the peritoneal cavity, or by growing along the lines of communication towards the sternum and passing backward in lymphatics that accompany the internal mammary vessels to the mediastinal space, or by growing along the anastomosing lymphatics from the opposite side may reach the other breast, are correct Still other routes may be chosen Knowing the lines of most active permeation will naturally influence the form of operation

The removal of large areas of skin as formerly practised does not now seem necessary Most recurrences in the skin have been shown to be extension of the process upward from the so dangerous fascia Any tissue that is abundant in lymphatics is a menace, because the lymphatics have been shown to be the most travelled routes by which cancer is disseminated Hence the most extensive removal of deep fascia and muscles extending not only to the axilla with the removal of its fat and glands, but extending inward past the border of the sternum and downward to the epigastric region, in order to cut off the different lines of advance of the cancer cell, is the logical procedure

To have a set form of incision I am satisfied is a mistake The location and extent should determine the line of incision and the amount of skin to be removed If the growth is deeply seated only a comparatively small amount of skin need be sacrificed If near the surface, and especially if the skin is adherent, a much larger area should be removed

The most methodical part of the operation, as well as the more extensive, occurs beneath the skin There is really no especial limitation to the amount of fascia and fat that may advantageously be sacrificed In

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the fascia one may be reasonably certain that there is microscopic invasion much farther than is macroscopically apparent

Volkman's three-year period of freedom from recurrence does not constitute a cure of cancer. Neither does a five-year period. A number in this series were free from recurrence more than five years, but later died of cancer. The longest period noted in any of them was a woman, operated October 31, 1904, at the age of sixty-eight. She was apparently free of all trouble until early in 1914, about nine and one-half years after her operation, and she died of the disease in December, 1918, more than fourteen years after her operation. I examined this woman several times and the recurrence came in the form of nodules over the chest wall, formerly occupied by the breast, and was a typical local recurrence and not a carcinoma originating as a primary growth. At least, that is the way it appeared to me.

In conclusion, my study of these cases and the results obtained are encouraging rather than discouraging. Operation for cancer saves lives. The very early operation, so early that the microscope is necessary to make the diagnosis, is bound to produce better results than the operation done after the disease is easily diagnosed. The radical operation should be directed in such a way as to remove as thoroughly as possible the highways along which the disease is disseminated.

The campaign of education of the public with reference to the signs of early cancer and its curability when operated early should be continued and kept up unceasingly. And finally the fact should be appreciated that every woman operated for carcinoma of the breast who remains free of the disease is more powerful propaganda in the community in which she lives than all the tracts that could be written.

DIAPHRAGMATIC HERNIA*

BY THEODORE F RIGGS, M D

OF PIERRE, S D

PROTRUSION of a portion of the abdominal viscera through an opening in the diaphragm, while by no means unknown, is perhaps more frequent than we realize. According to Giffin,¹ about 650 cases of diaphragmatic hernia had been reported in the literature up to 1912, and eighteen articles on this subject, from the point of view of the radiologist or surgeon, have appeared during the past two years. Since many of the diagnoses have been made only in the autopsy room and as a number of patients have been operated upon with the hernia unrecognized and unrelieved, it is probable, as Soresi² so clearly points out, that many a person is in discomfort to-day because of the failure to recognize the true condition present.

According to the authorities the great majority of diaphragmatic herniæ occur to the left of the midline. The case herein reported we believe to have been a true traumatic hernia on the right of the midline.

The patient, a woman, aged thirty-four years, weight, 170 pounds, height, 66 inches, was admitted to St. Mary's Hospital December 1, 1918. Complaint Vomiting ten to sixty minutes after nearly every meal. Family and personal history unimportant except that the patient has been strong and active, doing hard physical house and farm work. Present trouble began about two and one-half years ago and has been gradually increasing. The patient ascribes the beginning of her trouble to carrying a wash-tub nearly full of water. This she carried some fifty feet with the side of the tub resting against her abdomen. While carrying the tub she noticed a sharp rather sickening pain in the upper abdomen or in the angle of the ribs, which pain almost wholly ceased when she emptied the tub and was relieved of the weight. She, however, did no more work that day because of persisting nausea with a few unsuccessful attempts at vomiting. The next day she was seemingly as well as ever and for a time continued to do her usual work, but without attempting to repeat the tub-carrying incident. Recurring attacks of mild nausea and eructation at various intervals were noted during the first year, gradually increasing in frequency, and during the past year and a half the nausea and belching has been followed more and more by vomiting, until during the past six months the nausea has almost ceased and the vomiting has been noted to occur within ten to sixty minutes after nearly every meal. The vomitus consists of the food ingested, but rarely, if ever, has the patient vomited all of the food taken. There has been no appreciable loss of weight or

* Read before the Western Surgical Association, December 6, 1919

strength There has never been any severe pain since that at the onset No blood has been in the vomitus nor, so far as known, in the stools Liquids were perhaps less likely to be vomited than more solid food The bowels have always been somewhat sluggish and the patient thinks that during the past year this sluggishness has increased Menstrual history negative, the possibility of a pregnancy or of a pelvic tumor or inflammation was carefully considered and eliminated

Examination showed a rather pale, well-developed, well-muscled, rather fleshy young woman Temperature repeatedly normal Hæmoglobin, 70 per cent, leucocytes, 7600, blood-pressure, systolic, 134, diastolic, 80-85, urine normal Test meal an hour after eating showed a free hydrochloric acid of 26 and a total acidity of 49 A second specimen taken thirty minutes later gave hydrochloric acid 23 and a total of 31 Digestion poor and there was considerable mucus In the chest the lungs were clear and there was no restriction in respiratory movement The heart sounds were normal, but the area of cardiac dullness and the apex beat were noted to be about one finger breadth higher than normal Although the chest was separately examined by two of us there was no area of tympany found The abdomen was fleshy, full, and soft, with no tender area except on deep pressure beneath the costal border in the gall-bladder region The stomach outline was high but not unusually so, and there was no unusual dilatation or discomfort on filling the stomach with air The capacity of the stomach was about 750 c c, as noted on lavage

Following a barium meal the X-ray showed a high stomach, but very unfortunately the margin of the first plate came too low to include the pylorus The second picture taken an hour later shows the barium passing upward and to the patient's right through a constricted area proximal to the pylorus The patient vomited approximately half of the meal, and the succeeding bowel pictures were not satisfactory That we did not fully appreciate the second picture is shown by the fact that our choice in the a o diagnosis was a secondary gastric upset due to adhesions resulting from an old ulcer Looking backward it is easily seen that we should have made a correct diagnosis

Operation December 11, 1918, under ether anæsthesia Incision over upper right rectus Gall-bladder and appendix normal The peculiar fact was noted that no omentum and no transverse colon could be seen on first examination A portion of the greater curvature of the stomach was visible, but its margin was almost parallel to the incision On following the colon from near the hepatic flexure what should have been the transverse colon was found to pass upward and to the left of the gall-bladder where it was parallel to, and slightly behind, the greater curvature of the stomach The right and left lobes of the liver were widely separated along their lower margin just to the left of the point of juncture of the falciform ligament The transverse colon and the stomach were found to pass

upward in this separation of the liver and to pass through an opening in the dome of the diaphragm slightly to the right of the midline. Considerable difficulty was met in withdrawing these organs from the opening in the diaphragm, but when accomplished it was found that the contents of the hernia consisted of the pyloric portion of the stomach, the greater portion of the transverse colon and almost the entire omentum. Following the removal of these organs from the diaphragmatic opening, the patient at once ceased to breathe, but respirations were resumed when pressure was made closing the abdominal incision. The incision was then extended upward along the costal border to the midline and the hand was easily passed through the opening in the diaphragm. As nearly as could be told the cavity occupied the posterior part of the mesial portion of the right half of the chest. The heart could be felt pulsating to the patient's left and the lung tissue resistance could be felt anteriorly, to the outer side and above the hand. Posteriorly the ribs and bodies of the vertebræ could be easily felt through a thin layer of soft spongy tissues. There was a definite sac, but whether composed of two layers, the peritoneum and pleura, it is impossible to state. The opening in the diaphragm had its long axis anteroposteriorly and there was a distinct continuation of the diaphragm for at least two inches anteriorly and one and one-half inches posteriorly beyond the ends of the hernial opening, which easily admitted the examining hand and was fully three inches long. To close the hiatus four double sutures of No. 3 plain catgut were passed through the two pillars or margins of the opening, leaving the ends long, until all sutures had been placed, when they were tied. To insure a more permanent closure a portion of the omentum was lifted up and sutured over the opening. To pass the sutures in the diaphragm it was necessary to elevate the costal border, whereupon respiration would cease. It was therefore necessary to pass one stitch and close the abdominal incision by pressure until respiration was reestablished before attempting a subsequent suture. In the passage of one of the sutures the needle evidently punctured the pericardium or possibly touched the heart, as there resulted a sudden violent tachycardia. Needless to say, that needle was promptly withdrawn. Final closure of the diaphragmatic opening was apparently sound, for the abdominal incision could be held open without affecting the respirations. One small roll rubber drain was placed in the upper end of the incision with its tip carried down nearly to the line of suture in the diaphragm and the abdominal incision was then closed. Convalescence was uneventful except that during the second week the temperature ranged between 99° and 101° , probably due to a collection of fluid in the hernia cavity as was evidenced by relative dullness in this region. Whatever the cause, it gradually quieted down and the dullness disappeared. The displacement of the heart upward as noted before operation was entirely corrected and was doubtless due to the pressure of the displaced abdominal viscera. The patient was discharged from the hospital on January 5, 1919,

but was again seen on February 26 when a barium picture showed the stomach in normal position. There has been complete relief from the symptoms.

That the hernia was of traumatic origin we believe the history shows. That the opening was to the right of the midline we are certain. That the condition was not an elevation or relaxation of the diaphragm is proved by the definite limits of the opening. That the rupture was not through one of the normal openings in the diaphragm was shown by its position and the fact that no tissues passed through the ring other than those named.

Of the presence of a hernial sac or membrane we are sure, although we cannot be certain it was not a false sac developed by the long standing hernia. However, because the hernia evidently did not reach its maximum size at onset, because there were no adhesions of the viscera in the sac, and because the pillars of the split in the diaphragm were so evidently covered with peritoneum, we feel justified in believing the hernia to have been a true one, namely, contained in a sac formed by the diaphragmatic peritoneum and the diaphragmatic pleura.

If it be true, as seems likely, that the profession is not making as high a percentage of correct diagnoses in diaphragmatic hernia as in other more frequent abdominal conditions, the failure is probably due to lack of a sufficiently definite symptomatology. DeCourcy³ has formulated a few symptoms which point to non-traumatic cases of diaphragmatic hernia. Soresi² discusses fully the difficulties of outlining the symptoms characteristic of small diaphragmatic hernias which he says are never diagnosed, and he urges careful routine examination of the diaphragm. A comparison of the cases reported by Beckman,⁴ Giffin,¹ DeCourcy,³ and others brings out clearly the variations in, and the multiplicity of, the symptoms.

This is to be expected when one considers the many combinations possible, depending upon the location of the hilus and the viscera involved. It is reasonable to expect the traumatic hernia to be more easily diagnosed than the non-traumatic form, but one must remember that the severity of the symptoms is not necessarily in keeping with the size of the hernia. The possibility of a diaphragmatic hernia should, perhaps, be more often considered.

¹ Giffin, H. Z. *ANNALS OF SURGERY*, 1912, vol. IV, p. 389, and personal communication.

² Soresi, Angelo L. *ANNALS OF SURGERY*, 1919, vol. LXIX, p. 254.

³ DeCourcy, Joseph L. *ANNALS OF SURGERY*, 1919, vol. LXX, p. 179.

⁴ Beckman, E. H. S., G. and O., 1909, vol. IX, p. 154.

CONGENITAL DIAPHRAGMATIC HERNIA*

WITH REPORT OF A CASE

By LOUIS FRANK, M D
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SCUDDER, in 1912, could find only fifty-three cases of diaphragmatic herniæ which had been subjected to operation. Since then a number of cases have been recorded. We must, however, conclude that those of congenital origin are exceedingly rare and do not often come to operation. More rare, for evident reasons, are those, whether congenital or traumatic, occurring on the right side.

A careful review of the literature since Scudder's paper reveals only forty-one additional cases reported, and one of these a personal communication. We are forced to believe, however, from conversation with some of our X-ray friends, that there have been others, but whether they occurred in adults, or whether they ever came to operation, I have no means of knowing.

Of the additional cases recorded in the literature only five were reported as congenital, those observed and operated upon being accounted for largely by the trauma of war. Most of the cases occurred in soldiers as the direct result of missiles. In this type of case, also, it is a fact, explained by the anatomic position of the liver, that the hernia was almost uniformly upon the left side.

A study of these cases indicates that the abdominal method of approach is the most popular. This is easy to understand in cases of traumatic origin where a missile has entered the abdomen primarily. We find, also, that one patient with congenital hernia was subjected to gastro-enterostomy, this being the only feasible procedure to obtain relief from urgent symptoms which were present.

Of the additional cases which I have collected, two were observed post-mortem. One was advised against operation, the pathology having existed without much discomfort, according to the history, for a period of forty-five years, the patient at the time of diagnosis and presentation being fifty-nine years of age.

In the description of diaphragmatic hernia there is nothing to surpass—either from an anatomic standpoint, or from close study and analysis of the symptomatology in both strangulated and non-strangulated cases—that written by Cooper in his classical work on hernia published in 1804. He divides diaphragmatic hernia into three varieties, and I believe his division holds good to-day. He first classifies them into congenital and acquired. Under the congenital type he describes two

* Read before the Southern Surgical Association, December 16, 1919.

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varieties, one in which there is a distinct peritoneal sac, in the other there being no sac. The third variety also has no sac, this being entirely traumatic in origin.

A study of the literature confirms Cooper's opinion that congenital herniæ of the second variety are rarely seen, as the subjects usually die at birth or shortly afterward. In the first variety of the congenital type the individual may live for quite a period of years, and in his work Cooper mentions such cases, describing also cases of the second variety and of the traumatic type.

Among the illustrations to be shown in connection with this paper there are three taken from Cooper's work (Figs 1, 2, and 3). These were selected because of their excellence.¹

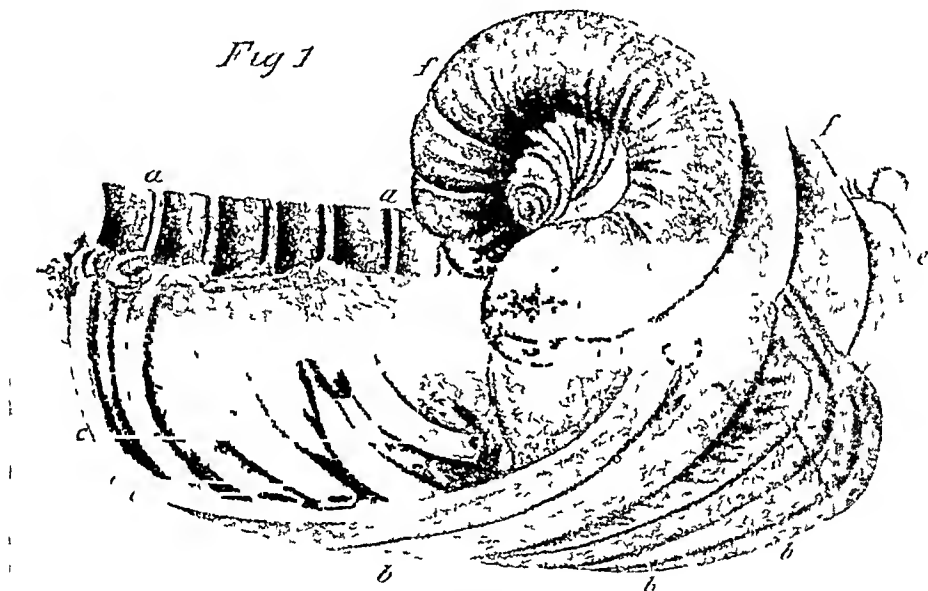


FIG 1 —Phrenic hernia caused by fracture of the ribs (From Cooper *Hernia* 1804-1844)

Beckman believed that the congenital type could not be benefited by operation, and the opinion was then expressed repeatedly and set forth in text-books on surgery that such herniæ should not be operated upon unless they become strangulated, and this seems to have been the general practice. Beckman says the congenital type are not true herniæ in that they have no sac. In the face of the reported cases, which have been carefully studied, this contention can hardly be maintained.

Giffin, in 1912, and Scudder in the same year reviewed most carefully and completely all the literature of this subject. At that time about

¹There is nothing to be found in modern literature which equals the description of the clinical symptomatology of congenital, strangulated diaphragmatic hernia which appears in the work of this famous surgeon of bygone and almost forgotten days. Those interested will find much valuable information concerning the subject of hernia in general in his book published over one hundred years ago.

one thousand cases had been recorded, though of these a very large proportion had been discovered only at autopsy. Scudder's study showed that there had been about fifty-three operations performed for diaphragmatic hernia at that time, and of this number thirty-nine patients had died. The thoracic approach was used in eleven, of which seven recovered, the abdominal approach in forty-two, of which thirty-five died. In these fifty-three cases deliberate operation based upon pre-operative diagnosis was performed in only six, the other patients applied to the surgeon for relief of intestinal obstruction, and, as he says, this is most



FIG 2—Phrenic hernia in the foetus g g bougie (passed through diaphragmatic aperture From Cooper Hernia 1804-1844)

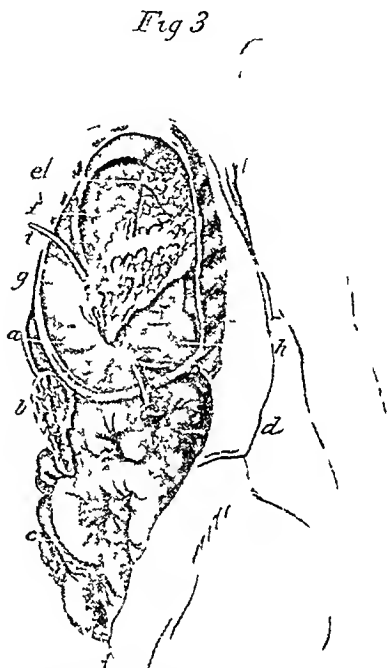


FIG 3—Strangulated phrenic hernia in adult
1 a bougie under strangulated colon and omentum (From Cooper *Hernia* 1804-1844)

likely the cause of the high mortality. The case reported by Giffin in 1912 is included as one of the six diagnosed before operation, though, if I read the report of Beckman correctly, three of his cases were also diagnosed before operation. We would recommend the articles of Giffin and Scudder to those who desire to pursue further studies of the literature of this subject.

Recently, as has already been said, probably as a result of war wounds, the subject has again been brought to the attention of the profession particularly by Soares, in a paper published during the current year. He reports one congenital and two traumatic cases, suggesting a method of closure to insure against recurrence of the hernia. We may say, in passing, that we know from experience it is not always possible to success-

fully execute a previously planned procedure for permanent cure in these cases. This is also well illustrated by Downes' case of congenital hernia in a boy about seven years of age, where it was impossible to restore the viscera to the abdominal cavity, necessitating on account of the extreme condition of the child a gastro-enterostomy to prevent starvation.

Downes believes from his experience that the abdominal approach is better, because in congenital cases where hernia has occurred through a dilated opening it may be impossible to correct the condition by approach from above. In our own case, as the citation will show, it was impossible to successfully deal with the condition through the abdominal incision, necessitating a trans-thoracic operation.

Attention is called by the author last quoted to the possibility of mistaking a full stomach herniated through the diaphragm for pyopneumothorax, and he states that several cases have been recorded in which such a mistake, followed by aspiration, terminated fatally. While in former years there may have been difficulty in diagnosis, we believe to-day with the aid of the roentgenologist and stereoscopic views the diagnosis can be accurately made in practically every case. In our own case no difficulties were presented after a stereoscopic picture was obtained.

Where a large portion of the stomach is herniated, the clinical history is similar to that of hour-glass or obstructed stomach, except that there are periods of remission and the symptoms begin in early childhood. However, the symptomatology, pathology, and etiologic factors have been so fully discussed in the literature that we will not consider them further in this paper, our desire being rather to report an interesting and probably unusual case with the difficulties confronting us in our efforts at relief.

CASE I—V. B., aged sixteen years, schoolboy, admitted February 2, 1919. The family history was negative. The boy had not been well since he was eighteen months old, at which time he had not yet been weaned. The mother noticed that he would frequently go the greater part of the day without nursing, and that often after nursing (during these periods) the ingestion of food was followed by vomiting. This was particularly true when he took much nourishment, overfilling the stomach, and was attributed to that cause. Later it was evident that the attacks of vomiting were induced by the recumbent posture. When the child was on his feet and going about he seemed to have less trouble. Vomiting was most frequent at night, and often the mother would remain up with him the greater part of the night on account of his apparent distress and his inability to retain food.

Vomiting was sometimes as frequent as six times daily, then again he would go for two weeks without an attack. For weeks at a time he would vomit food two or three times a week, and then he would be free of disturbance for a week or two. He did not gain rapidly in weight though continuing to grow. What he gained in

two or three weeks he would lose during the attacks. As a child he had almost constantly borborygmus without distention. This was often very annoying. The sounds were audible to those in the room and were relieved to some extent by belching.

Later as he took solid food he would have little or no trouble for weeks at a time when he would rapidly gain in flesh. For several years he had little trouble except occasional vomiting at night accompanied by much abdominal pain. He was able to attend school, but could not indulge in much exercise for fear of an attack. He subsisted largely on liquid and soft diet taken in small quantities at quite frequent intervals. He never had any cardiac attacks nor respiratory difficulty.

Present illness and condition. The patient comes on account of marked gastric disturbance which is irregular. He is having "attacks with his stomach" two or three times a week. During the attacks he has pain, "bloating of the stomach," and vomiting. He cannot eat without bringing on discomfort. This lasts a while, is followed by vomiting, the vomitus containing food eaten two or three meals previously, and after the stomach is apparently emptied he will again suddenly regurgitate or vomit more food. He can take only liquid and in small amounts, and even this at times induces vomiting of foul material. His trouble is made worse by the recumbent position. Epigastric discomfort is constant, but the vomiting itself is painless. The pain he has is not paroxysmal. There is no dyspnoea nor does he have palpitation. He has seen many doctors, has been in bed much, and has been X-rayed several times. Four weeks ago he had a mild diarrhoea, some clay-colored stools, and was slightly jaundiced (?).

Physical examination. A pale, anæmic-looking, only fairly nourished boy. Skin. No jaundice, though skin rather sallow. Sclera. Normal in color. Teeth and tonsils. Normal. Head. Negative. No enlarged glands nor evidence of glandular deficiency. Sexually. Mature. Heart. Negative for murmurs or increased size. Apex beat. Displaced upward but not laterally. No epigastric pulsations. Lungs. Thorax full at lower part, not normal wedge shape. Normal breath sounds not heard in lower chest, and seem altered over upper chest on right side, left side normal. Abdomen. Negative for tumors, pulsations, rigidity and tenderness. Genitals. Small right hydrocele, otherwise normal. Extremities. Normal.

Analysis of the gastric contents was not made, though stomach lavage was followed shortly by regurgitation of a small quantity of foul-smelling fluid containing some undigested food particles. The urine was practically normal. The blood examination showed a decided diminution in red corpuscles, normal number of whites, with hæmoglobin seventy per cent.

Our conclusions were that we had to deal with pyloric obstruction, *i e*, partial gastric obstruction. The patient was radiographed by Doctors Keith and Keith, of Louisville, whose report is appended.

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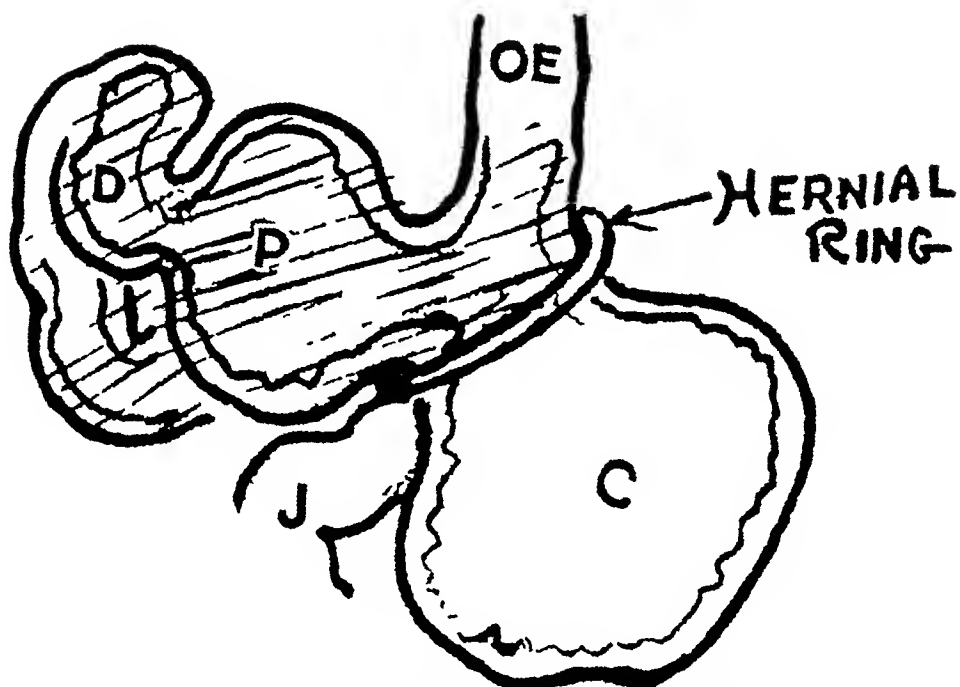


FIG 4 —Diagrammatic drawing after abdominal exploration Showing hernial ring with pylorus and duodenum within sac

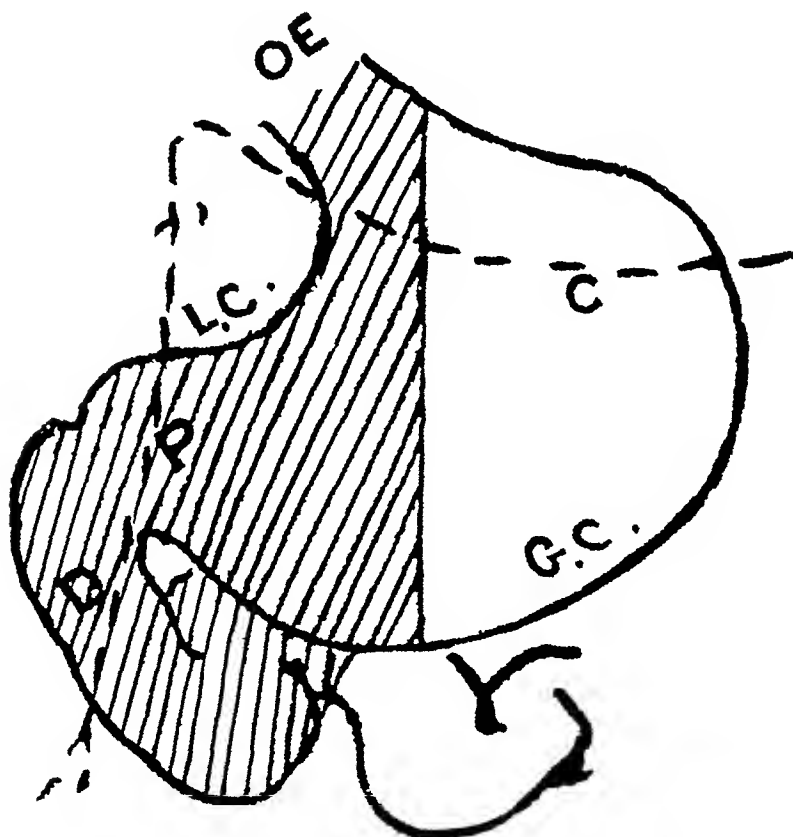


FIG 5 —Diagrammatic drawing after reduction Shaded portion formed hernial content

January 11, 1919 *Fluoroscopic Chest*—The cardiac and aortic shadows are normal. The diaphragm is mobile, the dome being higher on the right side than normal. There is no loss of contour on either side.

Barium Meal—There was a delay of barium at the cardia, with moderate dilatation of the lower end of the œsophagus for about three inches. The cardia is high under the ribs on the left side, the shadow being about the size of a fetal head, with no resemblance to the stomach shadow. After waiting a few minutes a small amount of barium was seen to the right of the spine, which gradually assumed a pear shape. This shadow was entirely under the

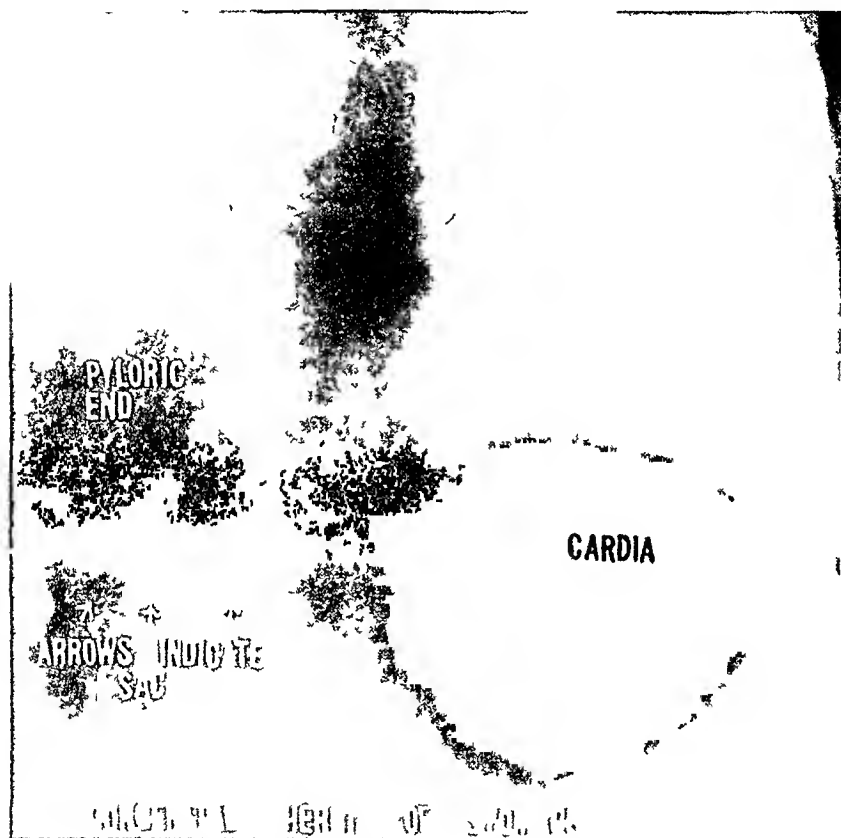


FIG 6—Röntgenogram immediately after ingestion of barium meal. Note duodenal cap within hernial sac.

costal cartilages and approximately on a line with the dome of the right side of the diaphragm. The shadow increased in size until about the size of a large orange, and pencil-shaped shadows could be seen connecting this mass with the mass under the ribs on the left side. Gas and fluid were seen around the shadow on the right side, and by violent percussions in the epigastrium fluctuation was elicited.

A Series of Plates show barium mass on the left side beneath the diaphragm the size of a small grapefruit. On the right side there is a much larger mass, with areas of lessened density or gas shadows completely surrounding this mass. There is no evidence of barium passing from the shadow on the right side into the small intestine.

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Three-and-one-half-hour Meal—Approximately 25 per cent of the barium had passed into the small intestine. No plates were made.

Six-and-one-half-hour Meal—Approximately 25 per cent of the meal remained in the stomach. Twenty-five per cent in the terminal ileum. The cecum and transverse colon were partially filled, the head of the barium meal being at the descending colon.

Twenty-four-hour Meal—Approximately 25 per cent of the meal remained in the stomach. Head of the meal had progressed to the rectum, the sigmoid and descending colon being well filled. The splenic flexure was much higher than normal.

Thirty-hour Meal—There was no change in the barium shadows.

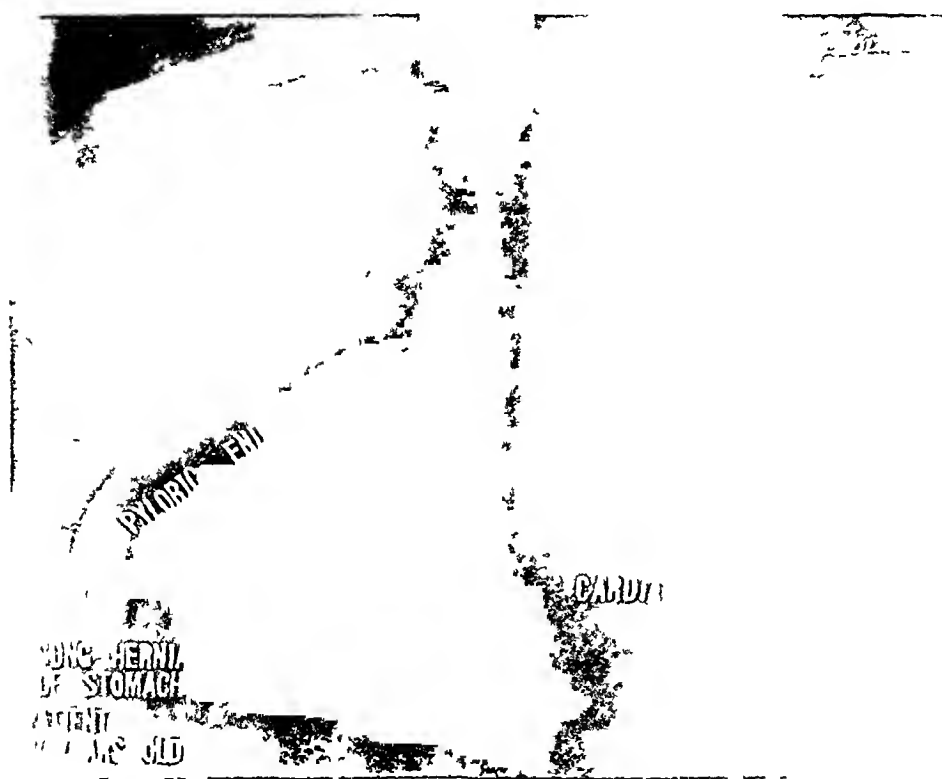


FIG 7—Röntgenogram with both sacs filled. Note cardiac shadow.

Forty-eight-hour Meal—Approximately 25 per cent of the barium remained in the stomach, being entirely to the left of the median line (in the cardia). No barium was seen to the right of the median line, but the fluid and gas shadows as described at first examination were easily visualized, and by vigorous palpation we could get movement in fluid and gas as fluid in chest when lung is collapsed.

Reexamination (January 31, 1919)—Barium Meal—The egress of barium from the œsophagus was seen to appear first to the right of the median line. After the barium shadow was the size of a large grapefruit it rapidly fell below the diaphragm and to the left of the median line. Evidently at this examination the stomach was entirely in the right chest, and as soon as moderately distended with barium solution the weight of the mass pulled the stomach into the abdomen, the cardia being visualized.

Plates made at this time gave the same type of shadows as at former examination

Diagnosis—Hernia of the stomach into the right chest The gas and fluid shadows we believe to be a sac for the hernia mass

A study of stereoscopic plates (Figs 6, 7, and 8) made it at once clear that we had to deal with a large diaphragmatic hernia, the contents almost half filling the right chest cavity and consisting certainly of half the stomach, *viz*, the pyloric end, with a large part of the duodenum

On February 4, 1919, an exploratory celiotomy was performed

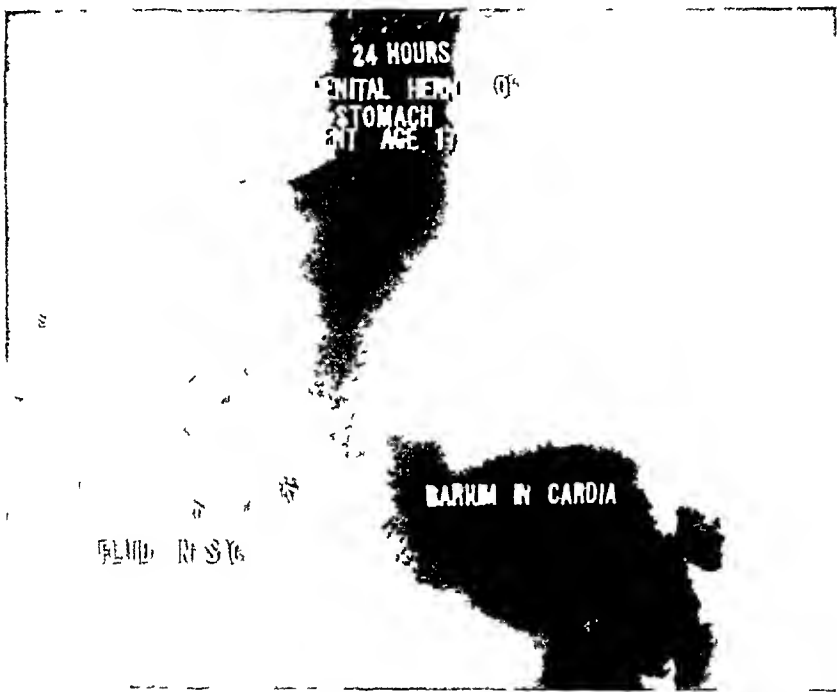


FIG 8—Röntgenogram twenty four hours after barium meal Air in hermetic portion of stomach gives appearance of air on the plate and was noted as fluid in sac

with the idea of ascertaining precisely what was the pathologic condition and if possible closing the opening by the abdominal route When the abdomen was opened by median incision the round ligament was immediately identified and the liver found pushed well to the right, the stomach with the duodenum, a large part of the omentum, and a small portion of the liver, were herniated into the right chest cavity through an opening which would easily admit four fingers (Figs 4 and 5) Reduction of the contents of the hernia into the abdominal cavity was attempted, and, while successful, was found to be most difficult on account of the negative chest pressure When the viscera were released they were at once aspirated again into the hernial sac The peritoneum was continuous into the sac, there being a distinct peritoneal covering of the

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hernial contents Dr D Y Keith was present at the operation which was performed under nitrous oxide gas The opening was so far posterior, in fact, being an enlargement of the œsophageal opening, it was found impossible on account of its location—not only deep and high in the cavity, but partially behind the liver—to effect closure The abdomen was then closed in the usual manner

On February 21 the second operation was done, the approach now being through the chest wall Under nitrous oxide gas 5 inches

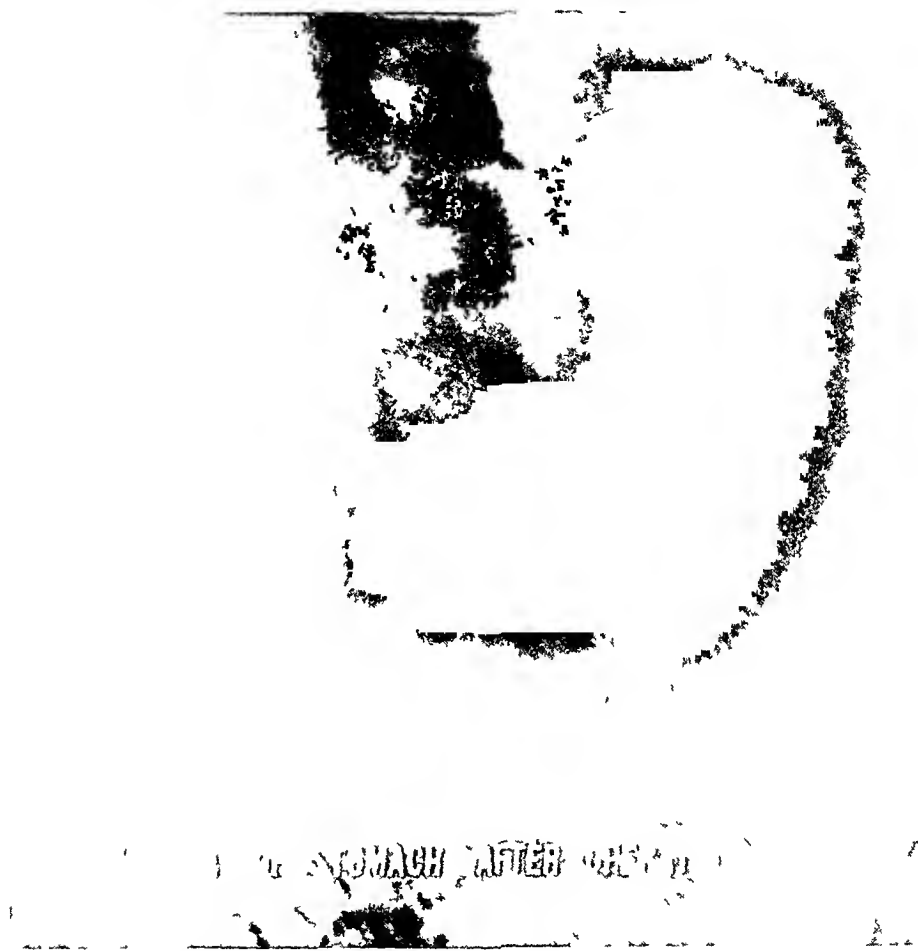


FIG 9 —Röntgenogram taken after dismissal of patient from the hospital, about one month after operation

of the seventh rib were excised (Figs 10 and 11) On account of the compression of the lung some difficulty was encountered in free exposure of the hernial sac The diaphragm was pushed upward and laterally and much thickened Directly over the sac there was no covering except thickened connective tissue and peritoneum No trouble was experienced from collapse of the lung, though no positive pressure was used with the nitrous oxide apparatus We believe this was due to the collapsed condition of the lung on that side Much trouble was encountered in replacing the contents of the hernia into the abdominal cavity, and even after this had been accomplished some difficulty was experienced in retaining the con-

FIG 10

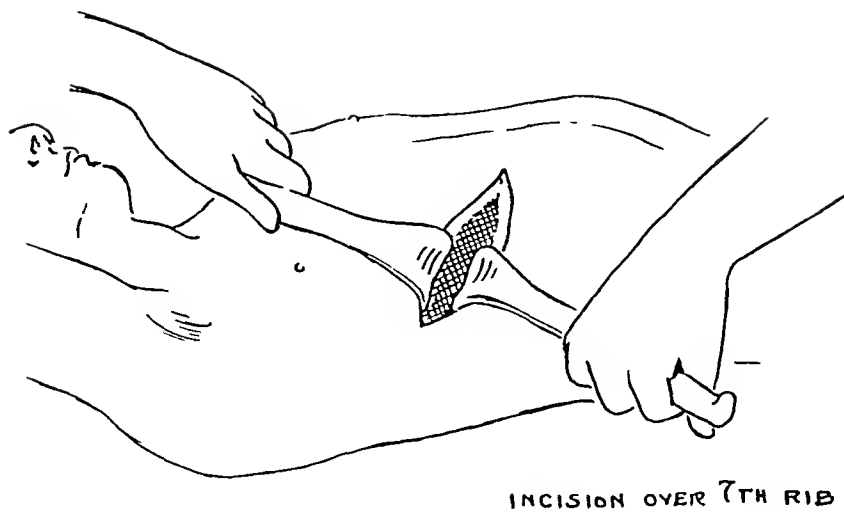
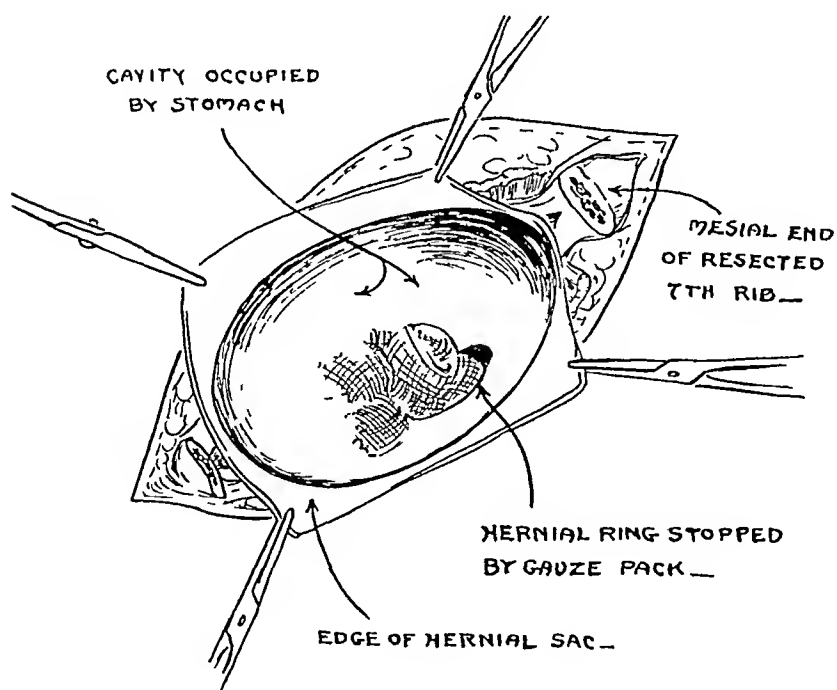


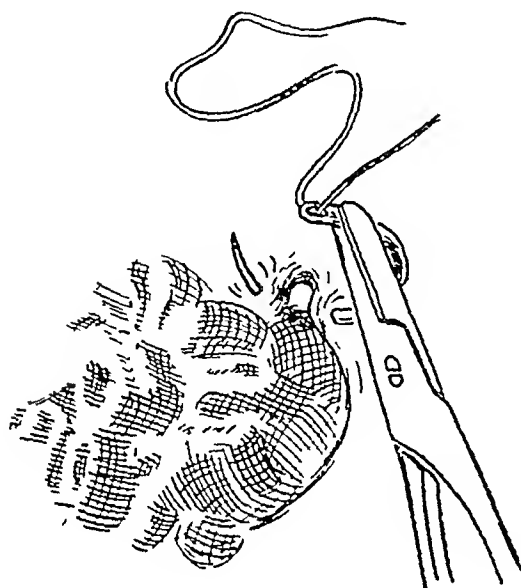
FIG 11



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tents The sac was not cut away, but was closed by deep through-and-through sutures extending from near the œsophagus directly across the neck of the sac These sutures extended into the abdomen and passed from the abdomen upon the opposite side outward into the sac again After tying these sutures the sac itself was

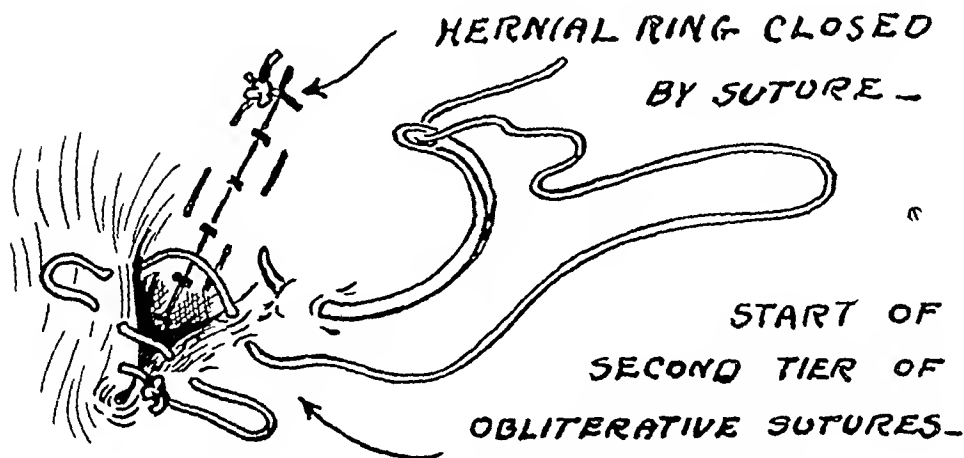
FIG 12



STARTING SUTURE OF
HERNIAL RING -

STOMACH RETAINED
IN ABDOMEN BY PACK.

FIG 13



HERNIAL RING CLOSED
BY SUTURE -

START OF
SECOND TIER OF
OBLITERATIVE SUTURES -

FIGS 10 13 —Various steps in the operation for closure of the hernia

obliterated by suturing with catgut (Figs 12 and 13) The thoracic muscles and skin wound were closed in the usual manner

Following the operation there was a rise in temperature to 102° F and pulse to 120 These subsided to normal on the third day, following which there was no further disturbance The patient was dismissed from the hospital on March 17, and a radiogram taken by Dr D Y Keith some time after his discharge showed the stomach in normal position The report of this fluoroscopic examination is as follows

There is no filling defect in the œsophagus or stomach, and many contraction waves were present. The stomach was partially filled with food before ingestion of barium. The greater curvature is two inches below the umbilicus. Cap fills normally under pressure and is very flexible. There is no irregularity on either curvature of the stomach or in the cap. There is moderate dilatation of the stomach shadow. There is no evidence of any portion of the stomach above the diaphragm. Fig 9

Additional literature with case reports since Scudder's paper in *ANNALS OF SURGERY*, vol. LV, 1912, p 261

- Stuart McGuire *Southern Med J*, September, 1914 One case
Ibid *Virginia Med S M*, December 25, 1914 One case
Moschcowitz *Operative Therapeutics*, Johnson, 1915 Two cases
Miller *Am J Obstet*, February, 1916 One case
Wood *Surg, Gynec and Obstet*, September, 1916 One case
Field *Jour Med Soc New Jersey*, May, 1916 One case
Siebert *Surg, Gynec and Obstet*, October, 1916 One case
Gordon *Brit M J*, August 19, 1916 One case, congenital
Balfour *ANNALS OF SURGERY*, January, 1916
Rayne-Jones *Arch Int Med*, February, 1916 One case
Green *J A M A*, July 15, 1916 One case
Vitrac *J Med, Bordeaux*, August, 1916 One case
Mitchell *Southern M J*, July, 1917 One case
Bevan *Surg Clinics, Chicago*, June, 1917 One case
McCleave *Am J Dis Children*, March 2, 1917 One case
Mercade *Presse Med*, March 22, 1917 One case, congenital
Martin-Du Pan *Rev Med La Suisse*, June, 1918 One case
Montandon *Ibid*, 1918 One case
Schaldemose *Hospitaltid*, June 26, 1918 One case
Hagen-Torn *Russ Vrach*, 1918
Downes *Surg, Gynec and Obstet*, October, 1918 One case, congenital
Gross *J Med Research*, July, 1918 One case
Dickie *Brit M J*, June 22, 1918 One case
Weidner *Kentucky Med Journal*, January 19, 1919, p 42 One case
McCandless *Journal Ront*, March 19, 1919, p 82 One case
Sores *ANNALS OF SURGERY* March 19, 1919, p 254 Three cases, one congenital
Berard and Dunet *Abs Jr A M A*, April 19, 1919, p 1193 One case
Barton *Br Med Jour*, June 19, 1919, p 767 One case
Greig *Edin Med Jour*, June 19, 1919, p 357 One case
Warren *Lancet*, June 21, 1919, p 1069 One case
Lake and Keim *Lancet*, July 5, 1919, p 13 One case
Landelhus *Abs, Jr A M A*, July 12, 1919, p 158 One case, congenital
Ware *Jr A M A*, July 26, 1919, p 267 One case
De Courcey *ANNALS OF SURGERY*, August 19, 1919, p 179 One case
Bennett *Br Med J*, August 16, 1919, p 203 One case
Andrew *Br Med J*, September 27, 1919, p 412 One case
Graves (Louisville) Society report, not published One case
Grewe (Cincinnati) Personal communication One case, congenital
Cooper's work on Hernia, 1804, cites two adult congenital cases

SURGERY OF THE DUCTUS COMMUNIS CHOLEDOCHUS

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GALL-BLADDER surgery, that is, surgery that has to do with the gall-bladder alone, is not, as a rule, difficult. Nor should it, in the absence of coexisting complications or the depreciations from previous diseases, have a death rate. The indifference shown by the gall-bladder to either an opening or a removal is, to my mind, the reason why so many arguments have been imposed in defense of opposing beliefs as to whether a cholecystotomy or a cholecystectomy should be the operation of choice. It is when we have to confront any of those alarming conditions that call for classic skill and knowledge, those accidents of disease, or the dynamics of a calculus, producing those lesions to the biliary tract that will kill unless properly dealt with, that our interest in the gall-bladder, of itself, begins to wane.

If there is a surgery more apprehensive, more trying, more full of depressing anxiety than that having to do with the repair of the bile channels exclusive of the gall-bladder and cystic duct, I have yet to encounter it. Two unmerciful oppositions impose their presence to the last, namely, inaccessibility and fragility of the structures involved. One hope, however, remains to prevent complete discouragement. Folds of peritoneum, either as strips from the gastrohepatic omentum or the great transverse mesocolon, or even the stomach itself, may be used to reinforce what otherwise might have to remain unattended. The peritoneum has the habit of throwing out exudate wherever fortification is urgent.

There are a few organs of which the surgeon is justly afraid. Such organs that will kill if disturbed too much. The pancreas is just such an one.

Ninety-five per cent of all known pancreas (postmortems) have but one duct patent into the duodenum—the duct of Wirsung. It is then of paramount importance that the surgeon, who is likely at any time to encounter a common duct lesion, have a concise knowledge of the embryonal and mature development of both the liver and pancreas together with their respective ducts.

The pancreas has its beginning in two anlagen. The liver from one. There is a time during embryonal development when the stomach is represented by a vertical, spindle-shaped tube, and the duodenum, immediately below, by a vertical, straight one. It is at about this period of the development that the three anlagen referred to above make their appearance. One that is above and to the right is that of the liver. One to the front of the duodenum is the ventral and the one to the rear of the duodenum the dorsal anlage of the pancreas. When the anlage of the

liver and that of the ventral pancreas bud their respective ducts, the process is so directed that the two become fused. From this fusing a third budding connects the two through a single opening into the duodenum. Following this comes the rotation, the half turn, to the right, of the duodenum, carrying with it, in the twist, the ventral anlage of the pancreas into apposition with the dorsal anlage behind, thus causing the duct from the liver to be sandwiched between. In time these two anlages are fused into the pancreas proper. The duct that meantime had developed within the dorsal anlage grows into that of the ventral anlage, and in five per cent of the known cases (Opie) becomes patent through an independent opening into the duodenum somewhere above the conjoined opening of the hepatic and the duct of Wirsung. The duct of the dorsal anlage becomes the duct of Santorini. That ninety-five per cent of the known pancreas have but the one duct patent into the duodenum, the duct of Wirsung, the first cause of pancreatitis is immediately apparent. Choke the ampule of Vater with either a calculus or a conglomerate of inflammatory débris, and unless the higher, or duct of Santorini, is patent pancreatitis, with all the dangers such an inflammation entails, will likely ensue.

From that portion of the upper margin of the pancreas where the common bile duct pierces the gland, down to where it joins the duct of Wirsung in the formation of the ampule of Vater, the surrounding glandular tissue so reinforces it that distention can only take place with difficulty. A biliary calculus, then, that is small enough to traverse this portion of the common bile duct is, as a rule, small enough to escape through the papilla of Vater.

Above the margin of the pancreas, however, it is different. Here a stone the size of a robin's egg may be forced along the duct until the pancreatic margin is reached, where unable to go further it may by pressure necrosis destroy the duct, and permit the stone and bile to enter the lesser peritoneal cavity. Unless such an accident is promptly dealt with, the bile soon reaches the general peritoneal cavity through the foramen of Winslow, where it will likely cause death by cholæmia.

In my own case of this character inflammatory action had sealed the foramen of Winslow. The stomach was pushed well forward by the accumulated bile beneath. This case was dealt with by implanting the stump of the duct directly into the stomach.

In his instructive treatise, "The Repair and Reconstruction of the Hepatic and Common Bile Ducts" (*Surgery, Gynecology and Obstetrics*, January, 1918), Professor Ellsworth Eliot, Jr., of New York, very kindly included the report of this case. The following is his condensed abstract of it.

CASE IV—(Reported by O'Day) Patient gave a history of repeated attacks of colic, the jaundice subsequently becoming persistent. On operation a fistulous tract was found leading from the perforated duct to the lesser peritoneal cavity which was

SURGERY OF THE DUCTUS COMMUNIS CHOLEDOCHUS

shut off from the greater cavity by obliteration of the foramen of Winslow. In the lesser cavity was found a considerable amount of bile containing one calculus. During an attempt to free the choledochus it broke off at a point just above the adherent mass in which the termination of the duct was embedded and abundant bile exuded from the

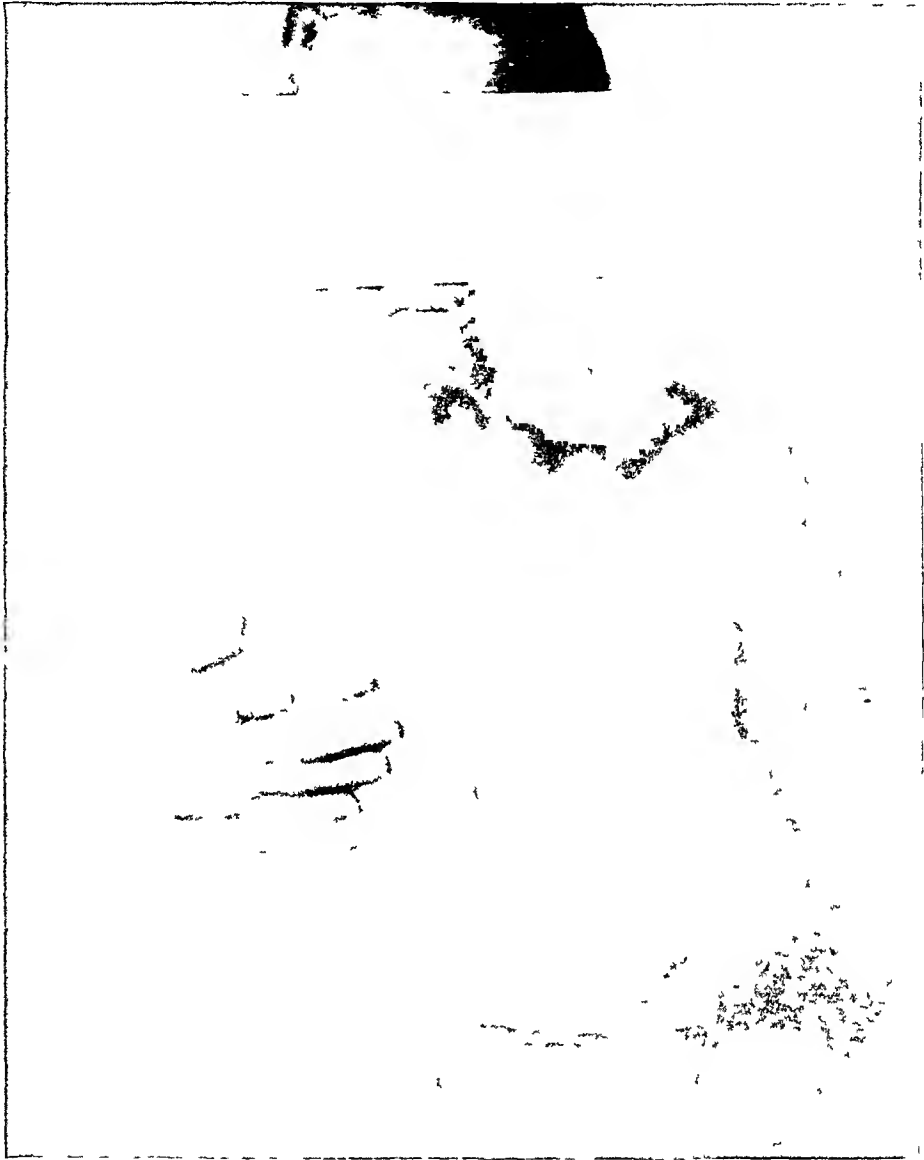


FIG 1 —Showing condition of patient eleven years after choledochogastrostomy for ruptured ductus choledochus

proximal end. An anastomosis was done between this stump and the anterior wall of the stomach in its lower one-third. The gall-bladder was obliterated and was not disturbed.

Recovery—Six years after the patient was in excellent condition without indication of any disturbance of digestion. The accompanying photograph (Fig 1) is the same patient eleven years after the operation. She has gained more than forty pounds in weight and has enjoyed every meal since.

Experiments together with case observations have brought us to the belief that jaundice of itself is not capable of causing alarming hemorrhage. But where both the

liver and pancreas are obstructed control of the bleeding during operative interference may be most difficult. In our experiments it was found that pancreatin added to fresh blood prevented clotting.

A case in point may be mentioned. Mrs. S., aged forty-two years, married, mother of four children. From the birth of her youngest child, then seven years, she dates the onset of her "stomach trouble." Periodical attacks of epigastric pain and a depression that seemed entirely out of proportion with the degree of the pain's severity. Before the attack would get well under way she would experience chilly sensations, and once the pain reached the height of its severity nausea would precede a profuse cold sweating. These attacks came and went at regular intervals until the last one which, owing to its character, was mistaken for an acute perforative gastric ulcer. Upon making our incision into the upper abdomen we were immediately confronted with a most alarming hemorrhage. Every point of the incised area bled freely. Nothing seemed capable of stopping it. With great difficulty we succeeded in getting to the stomach. It was normal. Our sponges continued to become saturated with blood, the patient's condition became critical, and while we closed the wound with frequently repeated through-and-through interrupted sutures, the oozing continued from between with alarming aspect. Death occurred within six hours and postmortem showed a large pancreatic calculus lodged at the junction of the duct of Wirsung and Santorini. Back of the stone the pancreas was completely obstructed. Its tissue was soft and swollen. The fibrous degeneration noted by Opie in his cases of pancreatic calculi was not present. There had been no glycosuria.

With the common bile duct completely severed at some point between the junction of the cystic duct and the upper margin of the pancreas, the danger may be obviated by the performance of cholecystenterostomy. But when this, for any reason, is impossible, a much more difficult problem is presented. In the face of such a problem the surgeon must remind himself as to whether or no he has, in his anxiety, taken anything for granted. The flood of bile encountered under these trying circumstances is so likely to convey the notion that the bile duct must be completely severed that, unthinkingly, he, himself, may, unless the truth is fully ascertained, complete what in reality is but a partial dissolution of continuity, and in so doing deprive his patient of the safest and surest means of a recovery, for while the slightest strip remains to connect the proximal and distal ends, the otherwise severed duct, with the application of proper drainage, is capable of restoring itself to complete functional continuity. What is proper drainage in such an emergency? It is the drainage that one establishes through a previously adjusted cofferdam. How is such a cofferdam best installed? Long, narrow strips of gauze are carried from the upper angle of the wound through an opening made in the gastrohepatic ligament, and their lower ends made to plicate around

the large rubber drainage tube previously carried down to the point of leakage. The way out the strips are stockaded around the tube, and the wound from just below this stockade to the lower angle closed with tight through-and-through silkworm-gut sutures. Strips of peritoneum from wherever they may be secured best (I have found from either the gastro-hepatic omentum or the transverse mesocolon) should be, with as much of their blood supply as possible, made to parallel the duct, for these strips will pour out exudate just where it is needed, and in this hasten what otherwise might prove to be a painfully slow regeneration.

When complete separation of the duct has actually occurred, and when, for any previous accident to the gall-bladder, cholecystenterostomy is out of the reckoning, how, then, is a biliary tract to be reestablished? Several methods are available.

With my own case, the one referred to by Professor Eliot, when it was encountered, implantation of the duct's stump into the stomach seemed the best and safest way out. The pouring of the bile into the stomach directly from the common duct, we reasoned, could do no less than make a gastro-jejunostomy admixture, nor did it, as subsequent events have shown, yet it fails to appeal as a procedure of choice.

A. E. Rockey divided the lower portion of the stomach, implanted the bile duct into the severed distal end, sutured the proximal end blind and completed the work by a posterior, no-loop gastro-jejunostomy. In another case the jejunum was divided a few inches below the duodeno-jejunal junction. The distal jejunum was carried up to receive the stump of the bile duct, passing in its ascent to the rear of the stomach through an opening in the transverse mesocolon. In this case the work was completed by an end-to-side jejuno-jejunostomy.

Any one of these methods is capable of restoring the function of the structures implicated, and the choice must, of necessity, rest with a clear vision of the existing condition of the interdepending parts. Stone in the ampoule of Vater can only betray its presence by obstructing. Such an obstruction becomes obvious when the proper examination of the biliary tract is made. To aid in this examination it should be remembered that such an obstruction causes the ducts, including the gall-bladder, to stand out full and tense. It is when this fullness of the common duct can be traced to the margin of the pancreas that obstruction within the ampule is betrayed. One cannot always be sure of the finger's excursion through the foramen of Winslow. True, a distended duct may be recognized, but nothing short of palpation from pancreatic margin to liver and gall-bladder is sufficient. It is my experience that such an examination is best made by drawing the stomach and transverse colon well forward and then through a rent made in the transverse mesocolon insert the examining hand into the lesser peritoneal cavity. When finally the duodenum has been opened, the papilla will be seen to pout, and this is

good, for it tends to make easy the dilatation necessary for the delivery of the offending mass. In our hands, the small alligator-forceps is the ideal instrument for such dilatation and delivery.

A case that had been examined by Dr W B Holden as well as myself, and reported later before the City and County Medical Society of Portland, operation was considered too risky because of a coexisting and rather severe glycosuria. The blood, however, bore little or no alarming sugar content, and upon this we modified our reluctance to operate. After a painstaking preparation the upper abdomen was opened. The gall-bladder as well as the entire biliary tract was found conspicuously distended. The pancreas, too, was markedly swollen. The papilla of Vater pouted prominently, and five small black biliary calculi actually shot out the moment we spread the opening with the small alligator forceps. The five stones had been conglomerated into one mass. A gush of bile followed. The reason we did not commit the common error of opening the gall-bladder first, was our inability to find the obstruction proximal to the upper margin of the pancreas. Compressing the gall-bladder while an examining finger rested on the common duct just above its dive into the head of the gland would cause a further bulging of the already distended tube. No jaundice or hemorrhage having occurred throughout the entire history of the case brought us to the conclusion that the duct of Santorini must have been inadequately patent into the duodenum. After we had closed the duodenum and turning our attention once more to the gall-bladder, it was found to be in a state of collapse. We now had the explanation of the gush of bile which had followed the conglomerated stones. Full recovery with never a return of the glycosuria was the reward.

It is a grievous mistake to open a distended gall-bladder before the exact point of the obstruction has been determined, for the moment it is done the hapless surgeon has forced himself to grope within a darkness of his own making.

A PERMANENT COLOSTOMY OR ENTEROSTOMY WHICH MAY BE CLOSED BY AN EXTRAPERITONEAL OPERATION

By ROBERT C. COFFEY, M.D.
OF PORTLAND, OREGON

IN modern intestinal surgery colostomy or enterostomy has a wide degree of application. There are many instances in which we now open the bowel to temporarily divert the fecal current from a pathological field or from a field of operation. Enterostomy or colostomy performed for this purpose may be required to functionate for months or years and should completely divert the fecal current. Colostomy of the Mikulicz type has usually been performed for intestinal growths where it was preferable to have the bowel drawn in and help to close itself as rapidly as possible after its work was performed. When an enterostomy or colostomy has been performed for the relief of pathology lower down, or for the purpose of protecting a surgical field lower down, it is necessary for the opening to functionate until the pathological lesion or surgical field has been restored to normal. This sometimes requires a long time. When the loops of an intestine have been sewed together and brought out through the abdominal wall in preparation for doing a Mikulicz closure later, there is a constant tendency for the loop to draw back into the abdominal cavity and effect a premature closure, thus defeating the purpose of the operation. On the other hand the form of permanent colostomy described by Sistrunk, Waibasse and others, in which a section of the abdominal wall is brought together under the loop, precludes any form of extraperitoneal closure. The following technic combines the features of a temporary and a permanent colostomy. A loop of bowel is drawn up through a longitudinal wound in the rectus muscle. This incision should be from two to three inches in length. The mesenteric borders of the two limbs of the intestine are sewed together, leaving some space at the apex of the loop. Two or three interrupted purse-string sutures close the mesentery back of this line in order to prevent a knuckle of intestine from becoming incarcerated in the space. Another line of sutures brings the free margins of the intestine together, thereby bringing two flat surfaces of the two limbs together. The loop of bowel is now sutured to the edges of the parietal peritoneum by a continuous lock-stitch of chromic catgut. A similar suture fastens the loop to the aponeurosis and muscle. A tongue-shaped flap of skin, one-half inch wide at the apex and about two inches long, is dissected from one side of the wound. A pair of artery forceps is thrust through the mesenteric space at the apex of the loop and the space is dilated. Through this space the strip of skin is drawn and sutured to the skin on the opposite side. After the skin wound has been closed with interrupted chromic

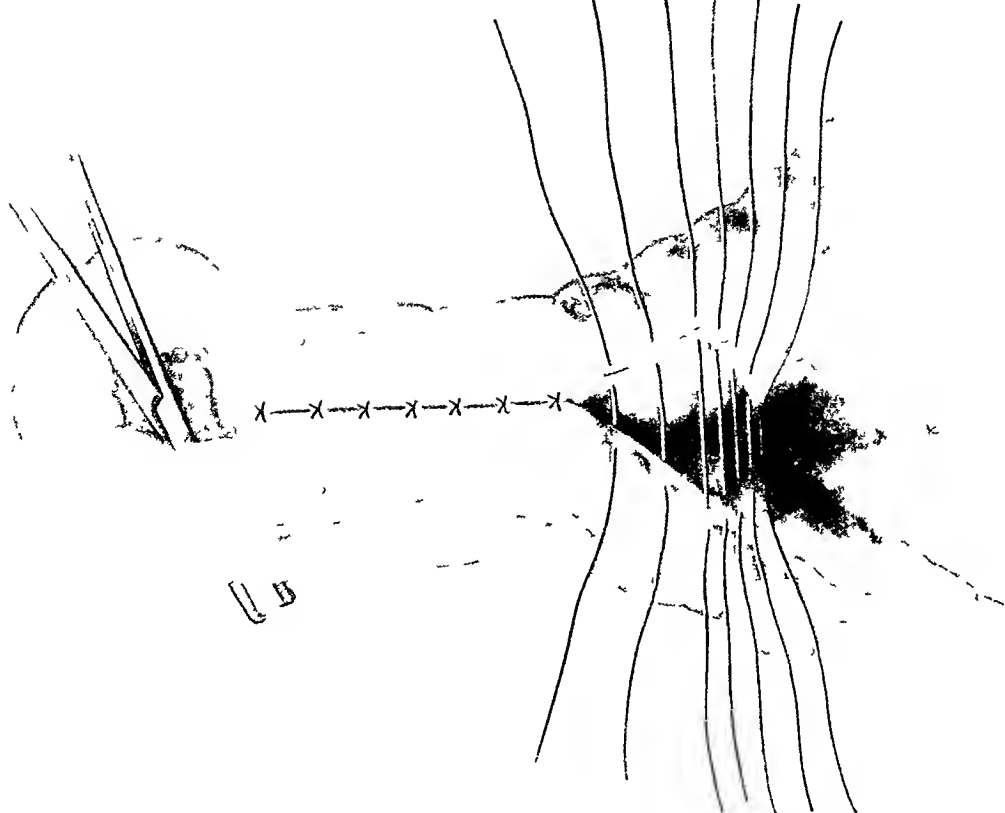


FIG 2

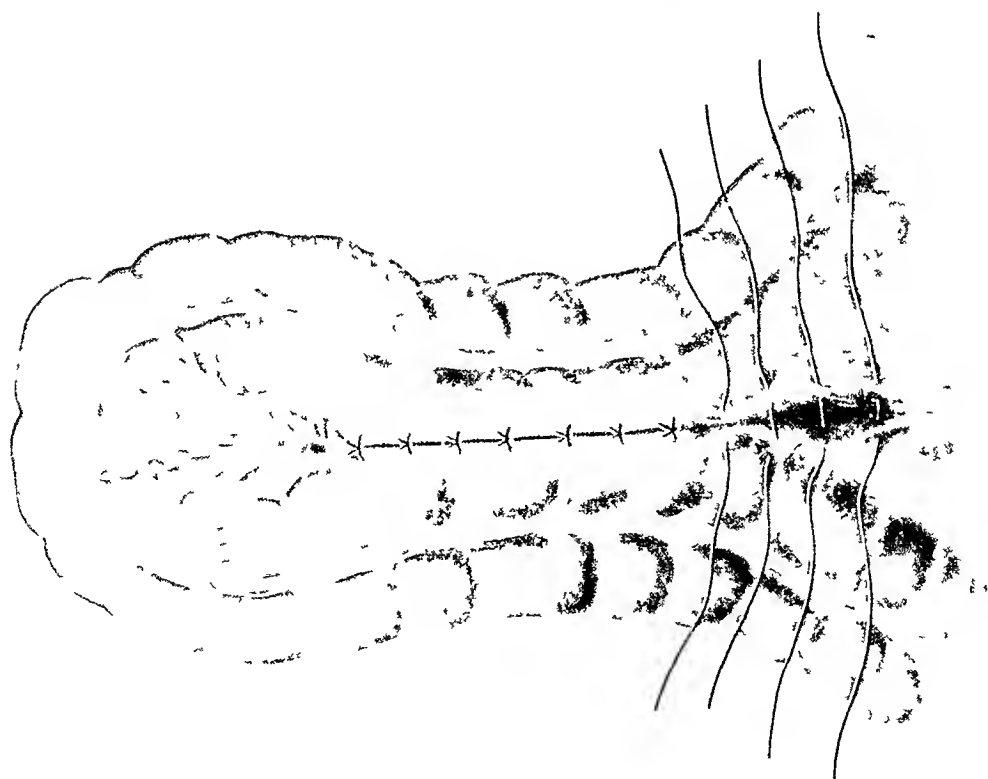
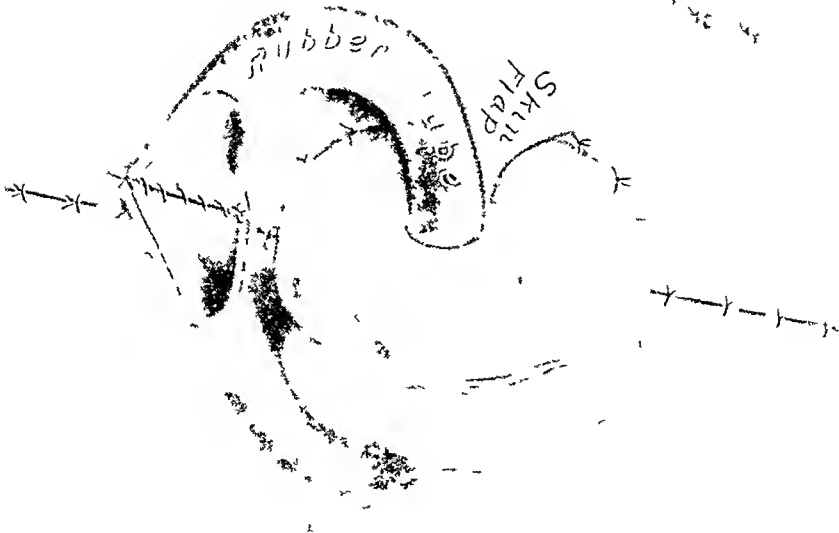


FIG 1



catgut sutures, which also fasten the intestine to the skin, a piece of rubber tubing is passed under the bowel on top of the strip of skin and made into a ring. This is for the purpose of carrying the weight and avoiding tension on the skin flap. The intestine is opened when it is

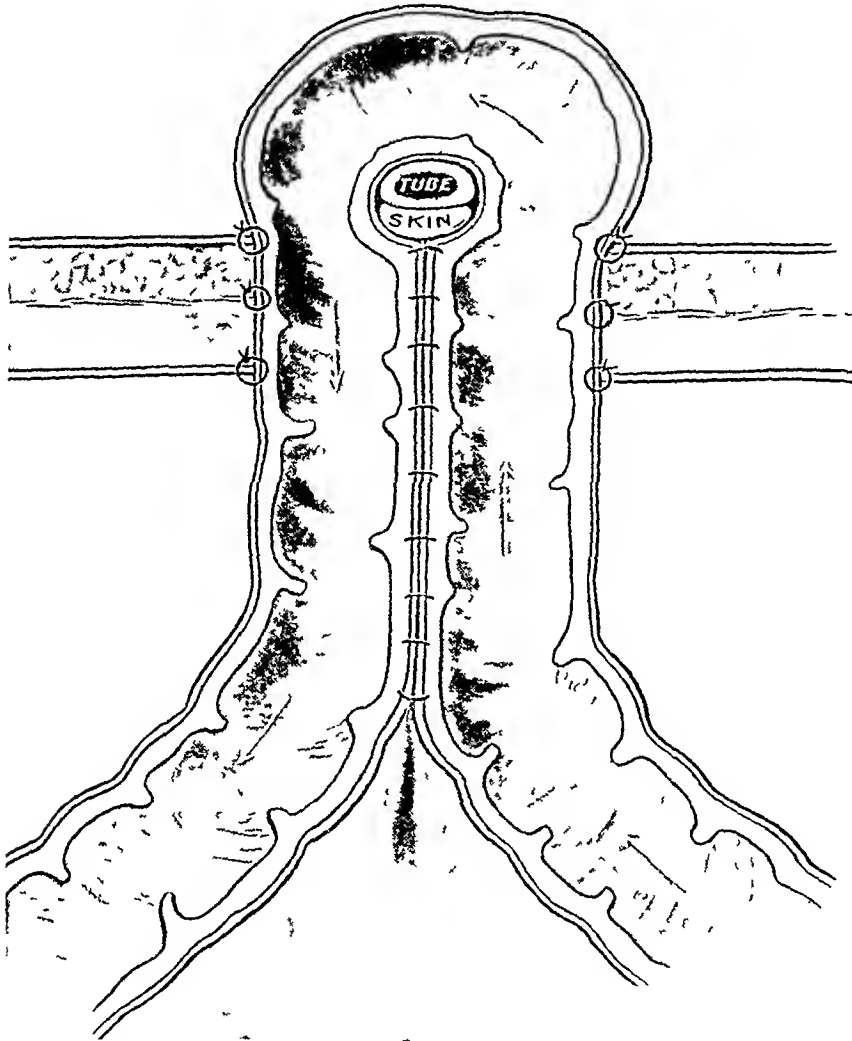


FIG 5

designed, completing the colostomy. When it becomes desirable to close the colostomy opening, the septum, including the skin flap under the loop, may be destroyed by pressure clamps.

The opening then becomes a fecal fistula, and may be closed by the extraperitoneal method described by me in the *ANNALS OF SURGERY*, June, 1907—also reproduced in the latest editions of Moynihan's "Abdominal Operations."

GASTRO-ENTEROSTOMY STILL THE TREATMENT FOR CHRONIC GASTRIC AND DUODENAL ULCER

BY ROBERT C. COFFEY, M. D.

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IN discussing the advisability of a surgical procedure for a given pathological condition, we have to consider several points

- 1 Immediate danger resulting from the operation itself,
- 2 Subsequent dangers more or less intimately associated with the results of the operation,
- 3 Amount of final relief of morbidity,
- 4 Life expectancy of patient following the operation for a given condition

This last topic has recently been discussed by Balfour in the November ANNALS OF SURGERY in connection with the study of gastric-duodenal ulcer. This is certainly going to open up one of the most interesting phases of the subject of our paper, but is one which can only be discussed knowingly after many more years have elapsed. However, Balfour's paper constitutes one of the most interesting contributions to this subject which has been presented for a long time. In our study of this subject I shall confine myself very largely to my own work, and shall include in this study every case of chronic gastric or duodenal ulcer which has been operated on in my regular operating hospital. This report does not include approximately twelve operations done outside of my regular operating hospital for the reason that I have had no opportunity to keep a record of these cases. Of these outside cases not reported here, one died as the result of faulty technic. I was holding a clinic in a distant city, demonstrating the "no-clamp" operation. The operating room was strange, and all assistants and instruments were unfamiliar to me. In addition to this, I was talking and operating at the same time. The surgeon whose case I was operating on spared me the painful news. After some months, I wrote him point blank, asking for the condition of the patient. He stated that the patient died from hemorrhage a few hours after the operation. Undoubtedly, in my effort at demonstrating, combined with strange surroundings, I overlooked a blood-vessel at the time of the operation.

Discussing statistics, we must remember that they are only of relative value, no matter how accurate or how long a period or how extensive the individual's practice. Therefore, statistics which include less than five or ten years of a man's practice, I would consider of very little value. Statistics which include a single year's work of a surgeon's professional lifetime are of no value at all taken alone. Statistics in which a man reports a hundred consecutive cases of major operations performed with-

out a death are far worse than valueless, as a rule, because, in the first place, the motive for presenting such a series of statistics is not scientific, but egotistic. We would all like to report such statistics, but when we consider the seriousness of scientific facts dealing with human life, they must be thrown out of consideration entirely.

My first gastro-enterostomy for duodenal ulcer was performed April 14, 1904, the last October —, 1919, but before I had performed a gastro-enterostomy for ulcer, I had done several hundred experimental anastomoses on animals, and had also mastered the through-and-through suture as taught by Connell, so that technically I was quite well prepared to do an anastomosis.

The total number of cases of gastro-duodenal ulcer treated by operation from April 14, 1904, to October —, 1919, was 233, the deaths from operation were 10—4.33 per cent.

In Balfour's paper, published in the November, 1919, *ANNALS OF SURGERY*, 2431 cases are reported as having been operated on in the Mayo Clinic between 1906 and 1915. Of these, 545 were gastric ulcers with 4.5 per cent mortality, which amounts to about 24 deaths. One thousand six hundred and eighty-four were duodenal ulcers, with 2 per cent mortality, or about 34 deaths. When thrown together and averaged, the total mortality of the Mayo Clinic for nine years, from 1906 to 1915, including 2431 cases of gastro-duodenal ulcers, is 58 deaths, or a mortality of 2.38 per cent.

The Massachusetts General Hospital reports for the four years—1911–1912–1913–1914—show 164 cases of chronic gastric and duodenal ulcers treated by operation with 11 deaths, or 6.7 per cent.

Peck reports the work of the staff of the Roosevelt Hospital, including a number of surgeons, which shows that from January, 1910, to June, 1915—five and a half years—104 cases of chronic ulcer were operated upon, with 10 deaths, or 9.6 per cent.

Finney reports 200 cases treated in the thirteen years from 1902 to 1915, with 12 deaths, or 6 per cent.

Eiselsberg reports ten years' work, from 1904 to 1914. In this, he reports 460 cases of gastric and duodenal ulcers treated by operation. Of these, 38 died, or 8.3 per cent. It is further noted in his paper that there were 41 pylorotomies in which the death-rate was not stated. This, undoubtedly, would have still further raised his death percentage.

It is very important to study the cause of death in this series. In my 233 operations for gastric and duodenal ulcer, the first case of death was No. 20 of this series, December 6, 1907. This was an old man, more than sixty years of age. The operation lasted more than two hours, although only a simple gastro-enterostomy was performed. He never passed any urine after the operation was performed, died in convulsions three days after the operation.

The second death was in case No. 43 of this series. He died October 28, 1910. The patient was a healthy man about fifty years

of age, with an obstructing ulcer at the pylorus, making an ideal case for permanent cure. Thirty hours after the operation the patient, who had been perfectly normal up to that time, began to show an increasing pulse rate without nausea, and without passage of blood from the bowels. He gradually grew weaker, and died twenty-four hours from the time symptoms began. Postmortem revealed the fact that the anastomosis was in perfect condition—evidently no hemorrhage at this point. Careful search revealed a slit about $1\frac{1}{2}$ inches in length in the mucous membrane, located about an inch from the anastomosis, running across this slit was a large open blood-vessel. The slit had been made by the pressure of the clamps, and the large vessel had been devitalized and exposed thereby. The stomach being in good condition, the hyperacidity marked, the wall of the devitalized exposed vessel had apparently been digested at this stage, and the hemorrhage began. Incidentally, I think I may state that it is probable that most cases of hemorrhage coming on from twenty-four to sixty hours after a gastro-enterostomy are due to this cause. Hemorrhage coming from the line of union should appear much earlier than this. Therefore, although clamps are of great service in the technic of an operation, it must not be forgotten that they offer a very definite danger.

Our third death occurred in case No 63, December 12, 1912. This followed a Rodman pylorectomy and gastro-enterostomy performed at the same time. This patient died of pneumonia, but was otherwise a very healthy man.

In the early stages of stomach surgery, pneumonia was the great danger. The dictum of Mayo and others, recommending the upright position for these patients, greatly lessened this danger. In our experience, we have learned to use about 3 grains of camphor in oil every three hours for the first twenty-four hours after stomach operation.

The fourth death occurred in case No 71, May 29, 1913. This followed an Eiselsberg exclusion operation with posterior gastro-enterostomy. Patient died with persistent vomiting of bile and acute dilatation of the stomach. A postmortem was not held, but I am sure that death was due to too much tension at the point of anastomosis, it sharply angulated the intestine.

Our fifth death occurred in case No 98, July 30, 1914, and followed an extensive sleeve resection for an ulcer along the lesser curvature. This patient died from shock within a few hours after the operation.

Our sixth death was in case No 108, January 6, 1915. The operation was an Eiselsberg exclusion, with posterior gastro-enterostomy. Patient died of regurgitation of bile and dilatation of the stomach, undoubtedly due to too much tension on the anastomosis by the stomach.

Our seventh death was No 120 of this series, July 9, 1915. About one-third of the stomach was removed, with the idea that it was probably malignant. The patient recovered from the operation as far as shock was concerned. On the second day, he began to

vomit bile, and any food which was put into his stomach. This kept up until on the eleventh day, a second operation was attempted, when it was found that a very short stub of stomach, passing through a rather short, fat mesentery, had made such a drag on the point of anastomosis as to funnel the mesentery and sharply angulate the intestine below the anastomosis.

The eighth death occurred in case No 137, March 7, 1916. In this operation a Finney pyloroplasty combined with a Balfour cautery operation for an ulcer on the lesser curvature was performed. Patient practically passed no urine from the time of the operation to his death, two days later.

The ninth death occurred in case No 182, October 18, 1917, as the result of hemorrhage coming on six days after operation. Hemorrhage came on very suddenly, and was repeated two days later with the result of death. Unfortunately, I was so engaged at the time that I could not have a postmortem performed, but this patient had an acute cold at the time of the operation, had a severe cough from the time of the operation until the hemorrhage took place, and probably had an acute ulcer developed at the site of operation, or had a broken mucous membrane, due to clamp pressure.

Patient No 180 died a month after leaving the hospital of empyema. This patient had a cold when he was operated upon, had a severe cough all the time he was in the hospital, which was no doubt followed by empyema after he left the hospital, producing his death.

We had two other stomach patients, Nos 183 and 184, in the same ward, who had very close calls as the result of infective colds developing in this ward. Incidentally, we may state that operation on a patient with even a slight cold is a very serious matter and should never be done.

The eleventh death followed an operation for duodenal ulcer which had developed in a patient who had had incomplete rotation of the gastro-intestinal tract. The duodenum went directly downwards on the right side of the spinal column, external to the ascending colon, and below the cæcum exactly in the same manner as noted in the arrangement of a dog's gastro-intestinal tract. The ulcer was large, quite acute, located well down the duodenum, near the bile duct, thus making excision or a Finney pyloroplasty impracticable, the duodenum running directly downwards from the bile duct was not very movable. There was no way by which the loop of intestine could be brought up for an ordinary type of posterior gastro-enterostomy except by a very long loop which must necessarily originate down near the cæcum. Therefore, an opening was made into the lesser peritoneal cavity back of and below the pyloric end of the stomach. This end of the stomach was drawn out through this opening for the duodenum, which had a very short mesentery. An anastomosis was made then between the stomach and the duodenum, about 2 inches below the ulcer. A good deal of tension was left, but it was thought that it would work.

The tension, however, seemed to be so great that it did not work, and on the fourth day after operation, the abdomen was again opened and a sharp kinking was noticed at the anastomosis, brought about by the pulling backwards of the stomach. Separating this and producing a better condition than the one before was quite an extensive ordeal and proved to be too much for the patient, who died a few hours after the second operation.

Another death occurred about this same date, but this case obviously has no connection with the operative mortality for duodenal ulcer, as will be shown by the following report. The patient came in having had apparently a total obstruction for several days, almost a total obstruction for a much longer time. The stomach contained large quantities of foul matter, patient was brought in for the purpose of emptying and cleansing patient's stomach for a day or two before any operation was attempted. When the nurse first introduced the stomach tube, the patient became strangled and began to cough violently. Soon he began to cough frothy blood, and went into quite rapid collapse, due partially to the hemorrhage and partially to the dyspnoea. A little later examination showed complete consolidation over the left pleura, no breath sounds on the left side. It was evident that the lung had been ruptured by the coughing. Patient remained in a doubtful condition for seven days. With a collapsed lung and no food whatever going through the pylorus, his condition became desperate. It was obviously necessary to get a quick opening from the stomach to the intestine, so under local anaesthesia the abdomen was opened and a quick gastro-enterostomy performed, with hope of getting immediate relief. This case, of course, became an emergency operation, and could not properly be included in operative results for chronic gastro-duodenal ulcer. It is mentioned here, however, because the case was referred for operation as a chronic duodenal case, and this report makes the record straight.

The most important thing about the second point of our discussion, namely, *remote post-operative complication*, is the formation of secondary ulcers. We have had secondary or recurring ulcers in the following cases:

No 44, following an excision of an ulcer located on the posterior wall, near the lesser curvature of the stomach. The lesser peritoneal cavity was opened and packed with gauze, stomach turned up and the ulcer excised from behind. The patient did fairly well for a few months, but soon began to develop her old symptoms. She came in for examination about three years later. The X-ray showed a definite hour-glass contraction. The ulcer has recurred and the patient is probably no better than if no operation had been done.

The next recurrence was in patient No 69 of this series. The ulcer was excised and the patient made a good recovery, but later has returned.

The third case, No 72, an Eiselsberg exclusion and gastro-

enterostomy, was performed for duodenal ulcer July 22, 1913. Patient did fairly well for a few weeks, but on January 23, 1914, six months after the operation, patient returned, and the ulcer had recurred. It was found in the stomach, distal to the anastomosis, was about two inches in diameter. The ulcer was excised and the opening closed. A year later the patient came back in a very weakened condition. The ulcer had recurred in practically the same place. Operation was again attempted, which resulted in the death of the patient.

The fourth recurring ulcer was in case No 83 of this series. First operation was performed January 5, 1914. The patient was a doctor, had had a previous exploratory operation for supposed duodenal ulcer. The previous surgeon had found a lot of adhesions in the neighborhood of the duodenum, but had failed to locate an ulcer, and had closed without doing anything further. On January 5, 1914, we did an Eiselsberg exclusion with posterior gastro-enterostomy. The patient was not as well after the operation as he should have been. A few months later he returned with certain symptoms of a recurrence. We opened the abdomen, found an ulcer about 2 inches in diameter in the stomach distal to the anastomosis. The ulcer, however, involved the anastomosis in this case. The anastomosis was cut off, ulcer removed, stomach closed, and intestine closed. Then a long loop anterior gastro-enterostomy was performed. In a short time the patient began to have trouble again. We did not look upon further operation favorably, and he was not getting satisfactory relief, so he went to Rochester. On the way there his secondary ulcer apparently perforated. He was in a very serious condition. In talking to Doctor Mayo, he was of the impression that a simple gastro-enterostomy had been done. Doctor Mayo opened him to relieve the acute perforation. The perforation had occurred well up on the left side. Anastomosis was cut off, and stomach and intestines closed. Twenty-four hours afterwards, the patient showed no evidence of bile or other secretions in the stomach, and was not doing well. Doctor Mayo wired me, asking what operation I had performed. I told him that I had done an Eiselsberg exclusion operation. He immediately took the patient to the operating room, and under local anæsthesia, drew the severed and closed ends of the stomach and duodenum together, and made an anastomosis. The patient made a good recovery, but soon began to show symptoms again, so three months later he went back to Rochester, when it was found that another ulcer had formed where the last anastomosis had been made. This ulcer was removed and a plastic operation was done. He did well for nearly three years after this, when suddenly he had a very severe hemorrhage, continuing for some days, which it seemed would produce a fatality. He gradually recovered from the hemorrhage, but was in a very desperate condition, was brought to me with a very extensive hernia from his numerous operations. The skin had become so thin that the intestines almost came through. Owing to the numerous scars, it was not thought

GASTRO-ENTEROSTOMY FOR CHRONIC GASTRIC ULCER

wise to open immediately over the stomach, so an incision was made in the healthy skin diagonally across the lower margin of the ribs and ensiform cartilage and the flap thrown downward till the stomach could be reached. Neighborhood of the stomach was surprisingly free from adhesions. The finger, passed down towards the pylorus on the outside of the stomach, indicated a hard ring around the outlet. An anterior gastro-enterostomy seemed to be the only hope of doing anything. A loop of the jejunum was brought up and sewed to the anterior surface of the stomach. The stomach was opened. A finger was passed downwards to the outlet, which was practically closed, and at which point another ulcer had developed. The anterior gastro-enterostomy was completed, and the patient has done very well ever since. His last operation was performed about five months ago. It is difficult to tell what the future has in store for this patient.

The fifth case of secondary ulcer was operated on December 23, 1915, No 134 of this series. Ten months after this operation the patient returned, having had severe symptoms for several months, and alarming symptoms for the previous few days. Patient was opened, secondary jejunal ulcer had perforated. The anastomosis was cut off, but the patient died with suppression of urine within forty-eight hours.

The sixth recurring ulcer occurred in case No 144 of this series. An hour-glass stomach, based upon an extensive old ulcer of the lesser curvature, also a duodenal ulcer, with a large indurated mass around it. The middle of the stomach was resected, and end-to-end anastomosis made along with a gastro-enterostomy distal to anastomosis. Patient did well for a couple of weeks, then began to show stomach symptoms. This was not very severe, so the patient got up and was around in very good condition. On the thirtieth day after operation, after taking a full breakfast, patient developed an alarming hemorrhage from the stomach, and died within thirty minutes. I was called and immediately did a postmortem, and found that a secondary ulcer about 2 inches in diameter had formed along the line of the circular anastomosis. Digestion apparently had corroded a large vessel which was standing wide open in the wound. The induration around the pyloric ulcer had practically disappeared.

The seventh patient to develop secondary ulcer was No 148 of this series. Operation was performed November 18, 1916. The ulcer was along the lesser curvature. Pylorus was wide open, so the Balfour cautery was used. April 20, 1917, the patient returned with the same symptoms. The ulcer had reformed and was much worse than when it had been cauterized before. At this time it was excised and a posterior gastro-enterostomy performed.

The eighth case was a patient who had been operated on. He came back complaining of severe diarrhoea. Immediately after eating any food his undigested food began to pass out through the rectum almost immediately after eating. After two weeks' observation the abdomen was opened, a large inflammatory mass was found, in-

volved the transverse colon and jejunum distal to the anastomosis. On further investigation, it was found that an opening existed between the jejunum and the colon, about $\frac{5}{8}$ inch in diameter. A jejunal ulcer had formed distal to the anastomosis, adhesions to the transverse colon had taken place, and an opening between the two intestines had been automatically established. The two intestines were severed, the openings closed, a large fold of omentum interposed between the two intestines and the abdomen closed.

In addition to these, a few of our cases have had severe hemorrhages several months or a year after operation, as will be seen by the tables. Whether these have been due to new ulcers or to the bleeding of the old ulcers, we are not able to determine. These cases have been without pain and usually have had but one or two severe hemorrhages.

Case 9, No 132 of this series, operated on December 2, 1915, hour-glass contraction based upon a large ulcer of the lesser curvature, severe resection.

It will thus be seen that of the 233 cases operated for ulcer, 9 have had definitely demonstrated secondary or recurring ulcers. Of these only two were following simple posterior gastro-enterostomy. About 3.8 per cent of the ulcers have recurred either at the point of excision or a new place. There are probably others which had not given so much trouble.

Of the 8 sleeve resections, two, or 25 per cent, have had recurrence of the ulcer. Two have had recurrence of the ulcer in the line of suture. Of the 11 cases of excision of the ulcer, either with the knife or Balfour cautery, without gastro-enterostomy, 3 have developed a recurrence of the ulcer. Out of 22 Eiselsberg exclusion operations, 2 have developed secondary ulcers, and these have recurred repeatedly after removal (3.9 per cent). While out of 165 simple gastro-enterostomies, only 2 have been known to develop secondary ulcers, about 1.2 per cent.

Of the 3 cases having severe hemorrhage at a remote period following operation, only one occurred in the 165 simple gastro-enterostomies—a little more than $\frac{1}{2}$ of 1 per cent, while 2 of the 22 Eiselsberg operations, or 9 per cent, in addition to the two definitely proved ulcers in this group, developed severe hemorrhage.

Now, what about the expectancy of life, as regards cancer, following ulcer treated by these various operations? Of the 233 cases thus operated upon for ulcer of the stomach and duodenum, 4 have been known to have developed cancer.

The first case we can report as having died of cancer, No 51 of this series, was operated upon May 10, 1911, for what appeared to be a duodenal ulcer located at the pylorus. A posterior gastro-enterostomy was performed. The patient died of carcinoma of the stomach in 1915, four years after the operation.

The next case, who was believed to have died of cancer, was No 74, operated upon August 4, 1913. An Eiselsberg exclusion opera-

tion was performed. The patient died two years later with stomach trouble and anæmia, it was thought by the family physician to be cancer. However, this may also have been a secondary ulcer.

The third, No. 81 in the series, operated upon December 29, 1913, for what appeared to be an extensive indurated ulcer. A Rodman pylorotomy was performed. Patient died of cancer of the liver a little more than a year later.

The fourth case to die of cancer, No. 143 of this series, was operated upon September 11, 1916, for an extensive saddle ulcer, 4 inches in one direction, and $4\frac{1}{2}$ inches in the other. The ulcer in no way resembled a cancer either from within or without. The middle of the stomach was removed by sleeve resection. Patient made a perfect recovery, developed ventral hernia, which was repaired six months later, at which time no evidence of recurrence could be detected, but the patient returned on the 7th of October, 1918, with a definite mass involving the liver, and all the evidences of cancer. He lived only a few months afterwards.

Thus, out of the entire 233 patients operated upon for gastric and duodenal ulcer, only 4 are known to have developed carcinoma, and 2 of these occurred in cases in which the ulcer area was excised, the other, if it was cancer at all, followed the Eiselsberg exclusion, and only one case, as far as we know, has developed carcinoma in the entire series of 165 simple gastro-enterostomies. However, I am frank to admit that we have not completed our follow-up system on these patients as we would like to, and other cases may show up later. The fact that we have been able to learn of only one case in the gastro-enterostomy list who has developed cancer, while there have developed 3 in the other much smaller list, is at least suggestive.

It is fair to state that the large saddle ulcer, on closer, later, microscopic examination, showed strong evidences of malignancy, so it had probably taken on malignancy when it was removed.

The case in which pylorotomy was performed was examined by an amateur hospital pathologist, and pronounced non-malignant. While we have not completed a systematic follow-up of all these cases, as far as relief of the morbidity is concerned, all the indications are so far that the general health of the patients who have had a simple gastro-enterostomy is better than those who have any of the radical or combined operations on the average.

In studying these cases from the four standpoints brought out in our opening sentences, we find the following:

From the standpoint of mortality, the simple gastro-enterostomy shows a total mortality of 4 in 165 cases, or 2.42 per cent. All other operations combined, including 67 cases, show immediate mortality of 6, or about 9 per cent. In the 165 cases of simple gastro-enterostomies, only two secondary ulcers have been known to result, while seven out of 67 of the more direct and radical operations, or more than 10 per cent, have developed

secondary ulcers Of 165 simple posterior gastro-enterostomies, only one case has developed cancer, while 2 of the 67 cases of excision are known to have developed cancer, and a third probably developed cancer

As to the relief of morbidity, all the evidence we have at hand indicates that the simple gastro-enterostomies have given better results from the standpoint of the recovery of the patients than have any radical operations

In discussing the question of cancer, of course, we must take into consideration that three-fourths of all the ulcers are duodenal These practically never develop in cancer, so that the cancers following ulcer are limited entirely to the 25 per cent found in the stomach

Another thing to be considered in a spirit of fairness is that the borderline cases are most likely to be removed by radical operation But making full allowance for all these matters from my own experience, I am fully convinced that the proper treatment of all gastric and duodenal ulcers from which the suspicion of malignancy can be removed with a fair degree of certainty, the proper procedure is as follows

To do a gastro-enterostomy and await results, no matter where the ulcer is located, if trouble develops later, it is then time to open and do a radical excision Excision, after a gastro-enterostomy has been performed, carries practically no mortality with it at all, no matter whether done with the Balfour cautery or by excision with a knife The Balfour cautery seems much simpler, and can be done much quicker

Concerning the *technic of gastro-enterostomy* we may briefly discuss the principles I think it has generally been conceded that the best application of the jejunum to the stomach is a short loop with the application of the jejunum downwards and to the left, ending at the greater curvature of the stomach, as recommended by Dr W J Mayo The suture material is still debated Dr C H Mayo for a while thought the secondary ulcer was due in certain cases to these stitches This, I believe, he concedes now is not always true At least one of the cases reported in our series shows 5 recurrences, 3 of which I believe were performed by the use of catgut exclusively Personally, I am afraid to risk catgut entirely, although I believe it is used at the Mayo Clinic with satisfactory results It is true that the external non-absorbable thread of a gastro-enterostomy is usually found hanging in the base of a secondary gastro-jejunal ulcer if the ulcer exists

In early experimental work on animals, I observed that an interrupted suture around an anastomosis, if it had penetrated the mucous membrane, would cut its way out in a few days If the interrupted suture did not penetrate the lumen of the bowel, and was used as a Lembert suture, these sutures would remain encysted in the peritoneum for many months without giving trouble A continuous linen or silk thread used for the inside suture was usually found for a few weeks after the operation, but eventually was thrown off in the bowel The continuous suture, which was intended for the peritoneal suture, frequently penetrated the lumen of

the bowel or stomach. Such a suture lying in the wound for months and even years, probably

While I am not convinced that a large number of secondary ulcers are due to such sutures, I agree that a large continuous, non-absorbable suture can certainly do no good, and probably in many instances does harm. Therefore, I never use a continuous linen or silk thread in an anastomosis. An interrupted linen suture, if it penetrates the lumen, will free itself in a few days. If it does not penetrate it, it will remain encysted so it can in no possible way do harm. In our work, then, we have adopted the principles of several operators.

We never give a stomach patient a cathartic the night before operation. A high flushing of soda—a teaspoonful to a half gallon of water—another early in the morning. If obstruction is considerable, the patient is given warm water by the rectum every four hours during the night. The stomach is washed before patient is brought to the operating room. After the abdomen is opened in the median line, or slightly to the left, a stomach tube is passed into the stomach, all gas and any fluid remaining allowed to escape. The ulcer is examined. If it is a duodenal ulcer, and is on the anterior surface, the omentum from above and below is drawn across the duodenum to take care of any possible fat perforations. The transverse colon is lifted, peritoneal fold corresponding to the ligament of Treitz located, the middle colic artery identified. This artery is usually found about the peritoneal fold mentioned. The transverse mesocolon should be opened in the large arterial loop to the left of the middle colic, and to the left of the peritoneal fold. If the fold extends far down, it should be clipped. Usually, there is a very small vessel running diagonally across the space where the mesocolon is to be opened. This vessel sometimes bleeds enough to make the field bloody. With two forceps, one on either side of the incision to be made, the clear mesocolon is picked up and cut through, exposing the posterior wall of the stomach in the lesser curvature. By examining the stomach above and below, the operator may get his bearings and pick up the stomach wall with two forceps, one on the posterior surface of the stomach, above its middle, toward the pyloric end, the other forceps should be placed toward the cardiac end of the stomach and near the greater curvature. The jejunum is directed toward the left, a short loop is picked up, a fold of gauze is placed between the stomach and jejunum to catch any discharge of blood or contents. The jejunum is picked up about 2 inches from its origin. A linen suture is passed through the outer wall of the intestine and stomach, near the mesentery border of the jejunum. This suture should pass beneath the holding forceps, and when tied should take its place. Another suture of the same kind picks up the jejunum near its mesenteric border about 2 inches caudad to the first suture. This suture is then passed through the outer coats of the stomach beneath the forceps near the omental attachment. The forceps are removed, these sutures

are used for traction loops. Another similar suture is then made to divide the space between these two loops. These spaces are in turn divided in the same manner, and so on until the required number of sutures are placed. These sutures are intended to go only through the outer coats of the intestines. However, if they happen to penetrate the lumen, no harm is done. After the row is completed, two quilt sutures are placed near the ends corresponding to the traction loops. After these penetrating quilt sutures have been tied, the first loops are cut away, and the deep penetrating loops are used for traction. A full line of quilt sutures are then placed between these two loops. These deep loops are made to grasp any large vessel which may show.

The walls of the stomach and intestine are then cut down to the mucosa until it herniates. A tannin catgut suture is then begun at the proximal end of the wound, and is made to penetrate the mucosa, and all thicknesses of the viscera. Large vessels along the stomach and intestines have all been caught with the forceps, a lock stitch passes down the whole length of the incision to serve the purpose of both strength and hæmatostasis.

At the distal end of the cut the stitch is securely locked, after which the stomach and intestinal cavities are opened. All bleeding vessels coming from the outside of the wound are caught. They may be either tied or held with forceps until they are caught in the continuous catgut suture. After turning the distal angle of the wound, the continuous suture is changed from a lock stitch to an in-and-out right-angle stitch, and continued to the point of beginning. This combination stitch was used by Dr C H Mayo many years ago.

Having completed the circle, the middle row of deep penetrating quilt sutures are placed, after which the row of interrupted peritoneal sutures completes the anastomosis.

One of the important steps of a gastro-enterostomy is proper suturing the mesentery borders and the stomach and intestines. It is very important that each stitch is carefully watched to see that the intestines are not twisted in any way. The mesocolon should first be sutured to the stomach by a few interrupted linen sutures. After this line is completed, a fold of the loose mesentery is drawn over to the jejunum by a few interrupted sutures. The space between the jejunum and the mesentery is closed with interrupted linen.

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DESCRIPTION OF A RATIONAL, SAFE AND EASY TECHNIC OF THE OPERATION FOR ACUTE AND INTERVAL APPENDICITIS

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IN all cases of appendicitis, the ideal time to operate in order to obtain the most ideal results *quoad vitam* and *quoad functionem* is obviously the first few hours after the first attack, but as the surgeon cannot select his cases, but must take them as they come, he should adopt a line of conduct that will minimize the dangers *quoad vitam* and give the best results *quoad functionem* in all cases. Such a line of conduct has certainly been in the mind of every good, conscientious surgeon, but it seems to us that the technic followed nowadays in general routine work does not answer to all the *desiderata* for a safe appendectomy in all acute cases. We propose, therefore, a technic to be followed in all acute cases, that will make appendectomy safe, rapid and easy of performance in all cases, and will render some of the most difficult and dangerous ones, such as cases with a gangrenous retrocæcal appendix not diagnosed as such, easy and safe to operate, and give the most satisfactory after-results.

We shall not enter for brevity's sake into a detailed discussion on the pathology of appendicitis, and on the old and yet unsettled question of when to operate, subjects that are treated in another paper in course of preparation, we shall only mention certain points that are indispensable to make clear the reasons why we advocate the procedure to be described.

Obviously the surgeon has to adopt as his motto, *primum non nocere*, the possible danger in all acute cases being due to the fact that infection might be spread by the manipulations indispensable to the performance of the operation and the resistance of the patient lowered. These dangers are more pronounced the more advanced is the case and the more abnormal is the position of the appendix. An exact diagnosis of the possible extension and severity of the infective process, of the condition and location of the appendix, is practically impossible in the greatest majority of acute cases, if not in all, therefore the line of conduct to be followed by the surgeon must be such that no matter what are the extension and severity of the infective process, and the condition and location of the appendix, the operation will never *per se* be a coefficient, that instead of improving the chances of recovery of the patient, might have been a handicap to his recovery. The operation must therefore always aim to prevent the diffusion of the infective process¹ by not disturbing the adhesions that the peritoneum has built, and which are the best barrier against the spreading

of infection and provide for a safe and positive exclusion of any infective material

The infective process can become dangerous if it spreads to the abdominal organs contained in the peritoneal cavity, therefore the abdominal organs must be protected against any infecting material, and their resistance against infective agents must not be lowered. The best way to accomplish this is to operate in such a manner that no abdominal organ, through which infection can be spread, is disturbed or traumatized,

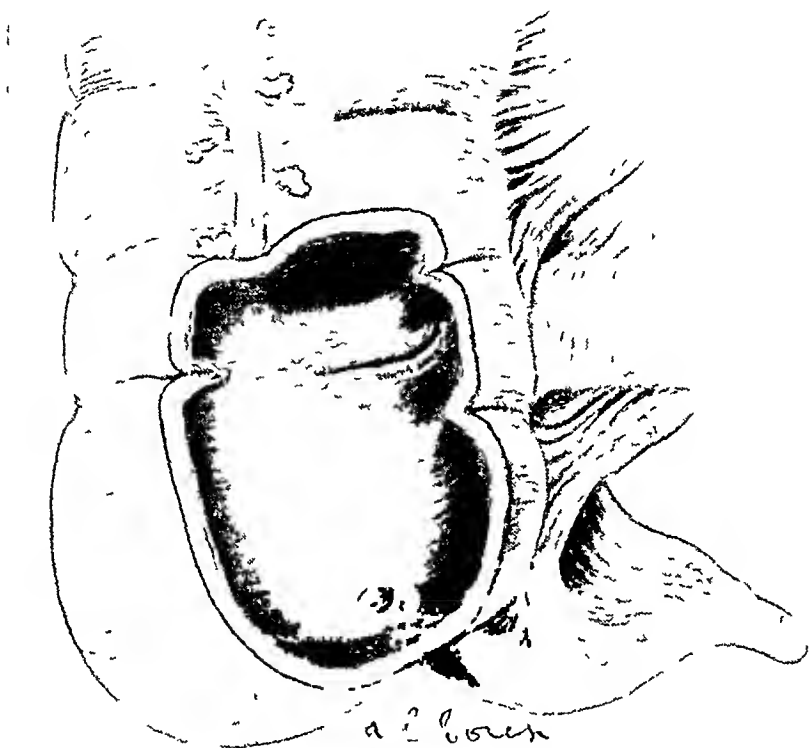


FIG. 1 — Normal position and relation of appendix (front view)

so that infection of the peritoneal cavity is absolutely prevented in all cases, no matter how advanced is the infection and what is the condition and location of the appendix, naturally, in the cases when the peritoneal cavity is already infected, the procedure we advocate can only aim to prevent a further spreading of the infection and not to weaken the resistance of the peritoneum

The aim of the surgeon is the removal of the appendix. Naturally in order to remove the appendix the surgeon has to know first where the appendix is located. Is there a fixed position where the surgeon has the certainty of finding the appendix? No, what we call the normal position

of the appendix and which is well illustrated in Figs 1 and 2, is met only in a comparatively small number of patients among the ones who are operated for acute appendicitis, probably because the persons who have a perfectly normal appendix are much less subject to appendicitis than the persons who have what could be called an abnormal appendix. Anatomically the appendix might be short or long, have a very long or short meso, be thick or thin, be located in numberless positions (Fig 3), and contract close relations or adhesions with any abdominal organ (Figs

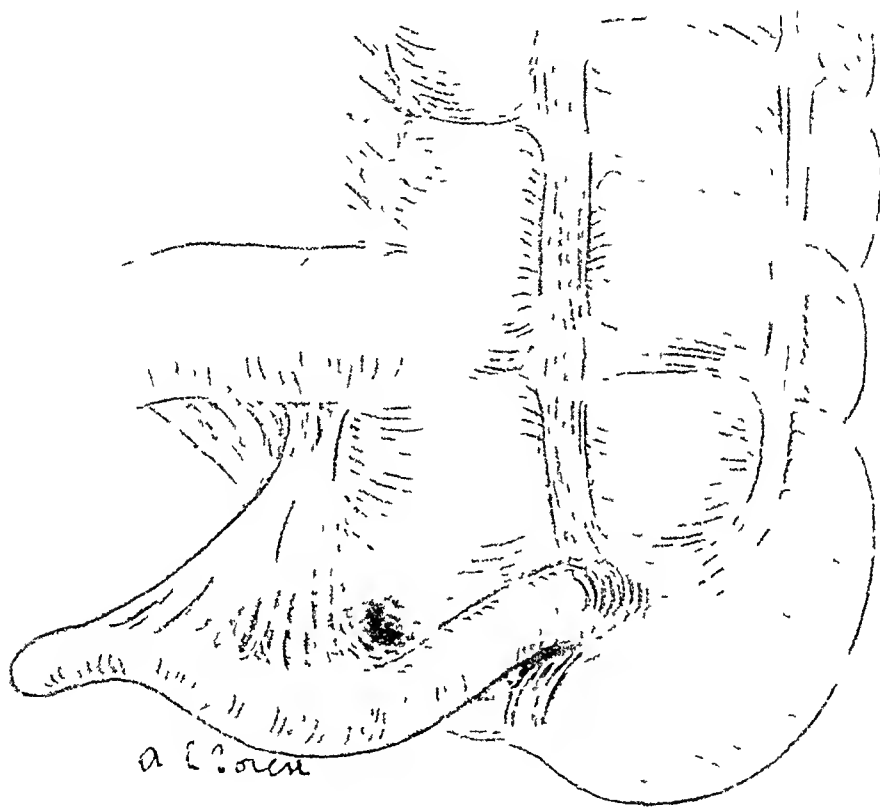


FIG. 2.—Normal position and relation of appendix (back view). Note in Figs 1 and 2 that point of emergence of appendix from cæcum or base of the appendix is a fixed point in all cases whence the appendix can be traced and located very easily.

3 and 4) However, no matter how changeable are the shape, position, size and relations of the appendix, there is one point which is always fixed, this point is its implantation on the cæcum, or what could be better called, its base. The base of the appendix is located in all cases on the inferior inner side of the cæcum, two or three centimetres below the ileocecal valve, exactly at the meeting point of the three muscular bands of the large intestine, this point is called the fixed appendicular point (Testut et Jacobs—Anatomie topographique) (Figs 1, 2, 3, 4, 5, and following). This point is so fixed that when the cæcum is not in its normal position,

the base of the appendix is found to have also the same abnormal relations of the cæcum (Figs 5, 6, 7, and 8) If anatomically the diseased appendix has no fixed position the search for it becomes more difficult on account of the pathological conditions resulting from appendicitis. Indeed, as soon as an inflammatory process of the appendix takes place, the peritoneum reacts in order to limit the infective process by creating adhesions, therefore, on opening the abdomen the surgeon will always find

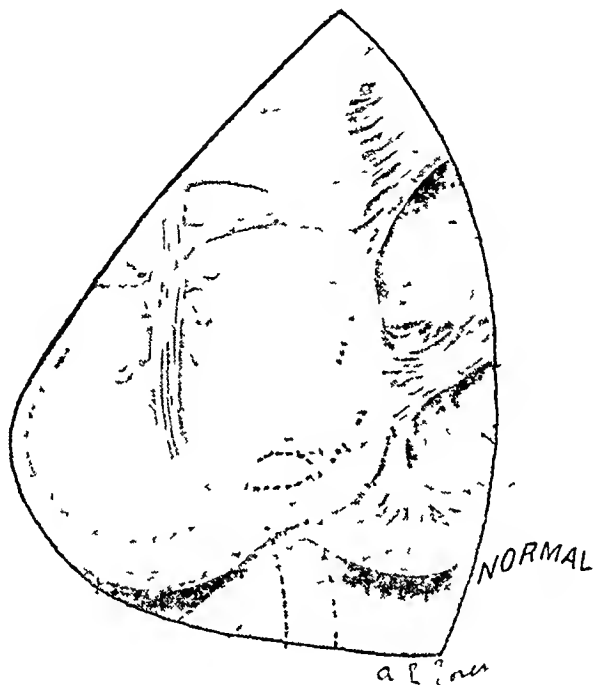


FIG 3.—Ordinary position of the appendix. Normal position is marked so, but any of the other positions are met very frequently at operation and in post mortems and are compatible with perfect health. Note difficulty of tracing the appendix through the McBurney incision when the appendix is not in its normal position.

in the advanced cases more or less abundant and dense adhesions binding together some of the intraperitoneal organs, these adhesions might also include a collection of pus, blood, serum, fecal matter, etc., which collection might be completely walled off and therefore separated from the general peritoneal cavity, or might be diffused more or less in the peritoneal cavity itself. At any rate, the presence of adhesions makes the search for the appendix more difficult and always more or less dangerous for the patient. Indeed, to search for the appendix in an acute case means that a number of the adhesions must be broken, even if the appendix is in a rather accessible position as shown in Fig 9, because even if the surgeon should be so fortunate as to

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fall immediately on the appendix, he must loosen up the parietal peritoneum, the omentum (which was removed in the illustration in order to make it clearer), must break the adhesions found in immediate contact with the appendix and between the inner portion of the cæcum and the loops of ileum, in this manner opening numberless avenues through which

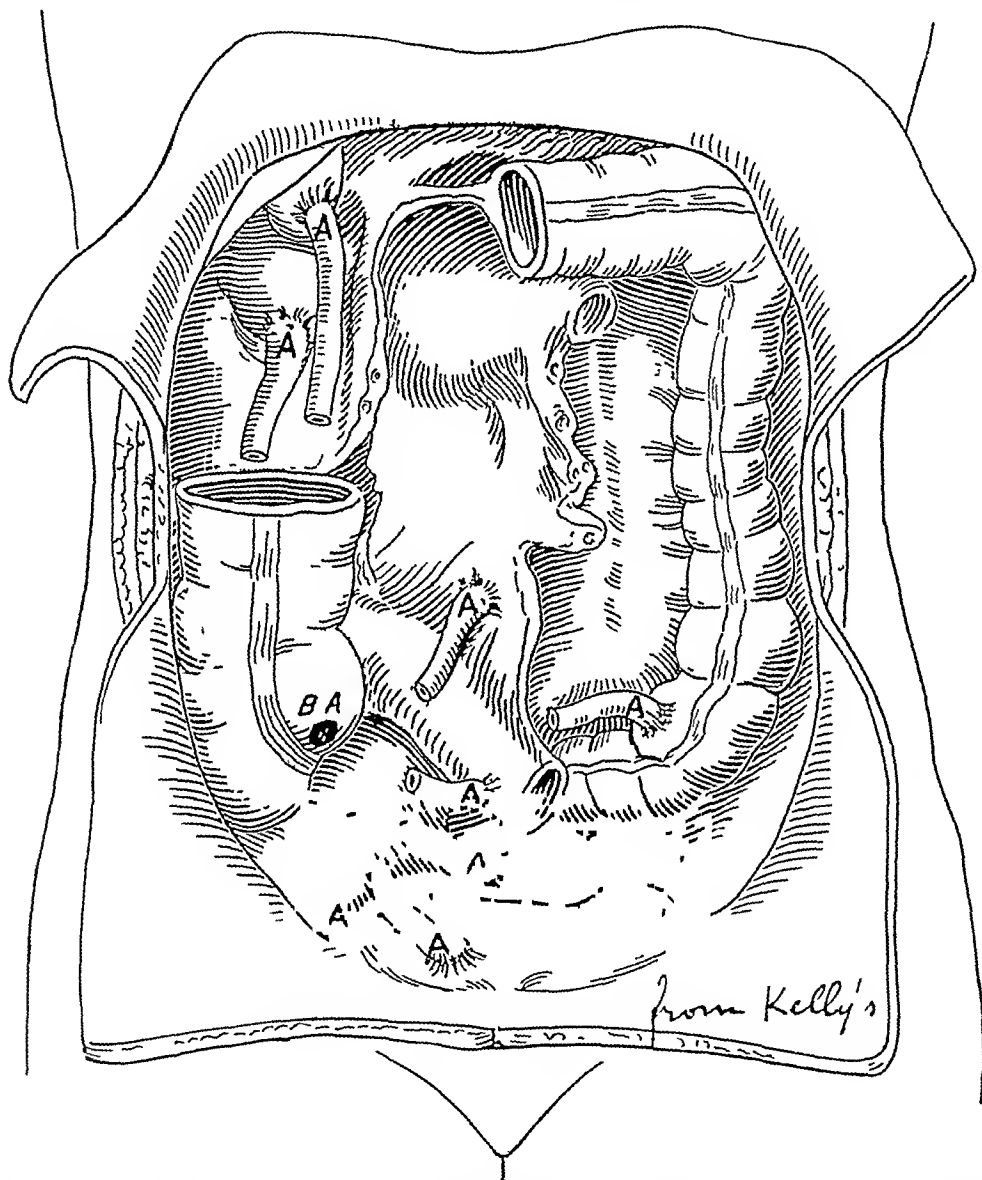


FIG 4 —Possible locations of appendix (A) and relations that it can contract with any other abdominal organ. Note that whatever the position of the appendix its base is always found in the normal position (BA) and can be traced from that point (From Kelly's Appendicitis)

infection can be spread. Matters are even worse in a case such as the one sketched in Fig 10, where the appendix cannot be seen and may be located anywhere, so that in the search for it the surgeon must break numberless valuable protective adhesions and spread infection. If we add to all this the inconvenience of working, as is often done, through a small McBurney incision, the trauma caused by retractors, pads, surgeon's hands, the possible breaking of an abscess, etc., we have not to

FIG 5

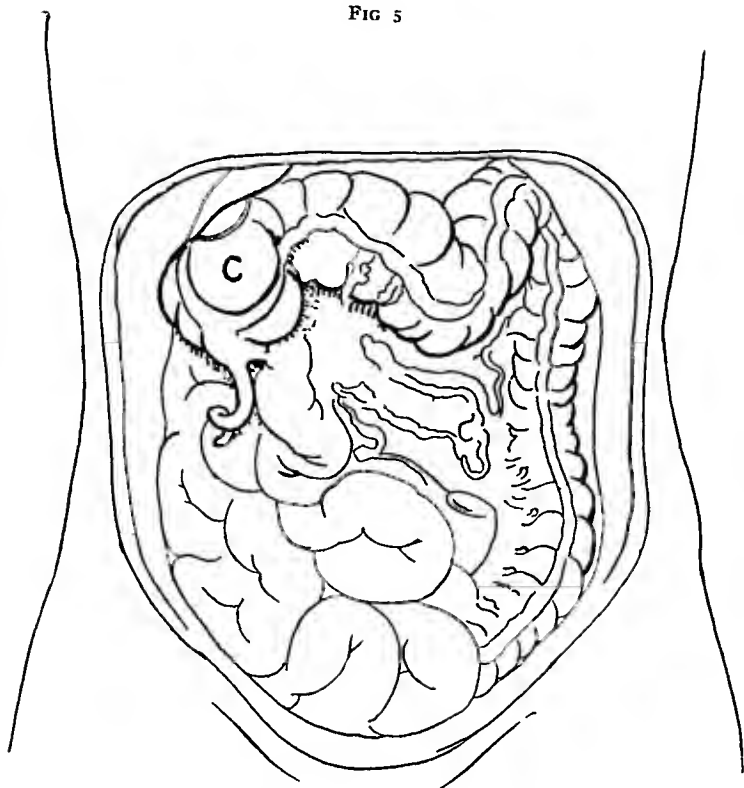
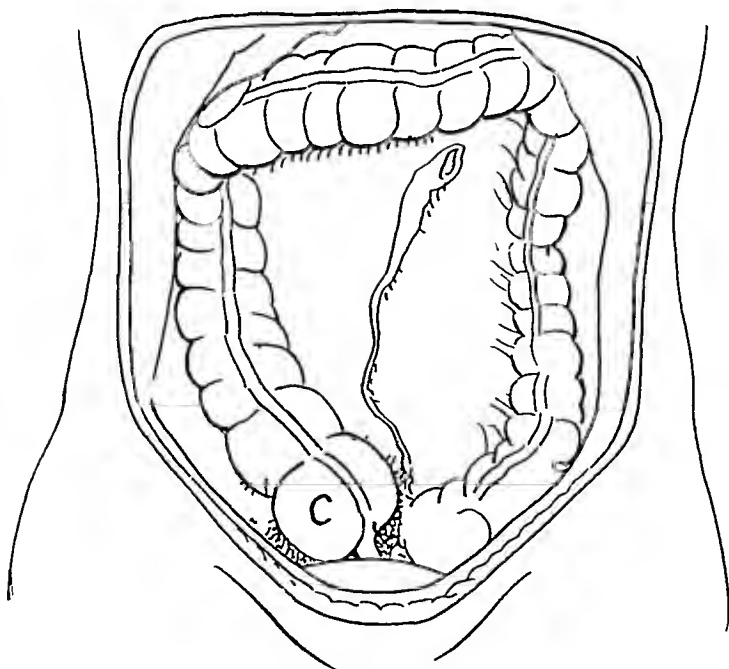


FIG 6



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FIG 7

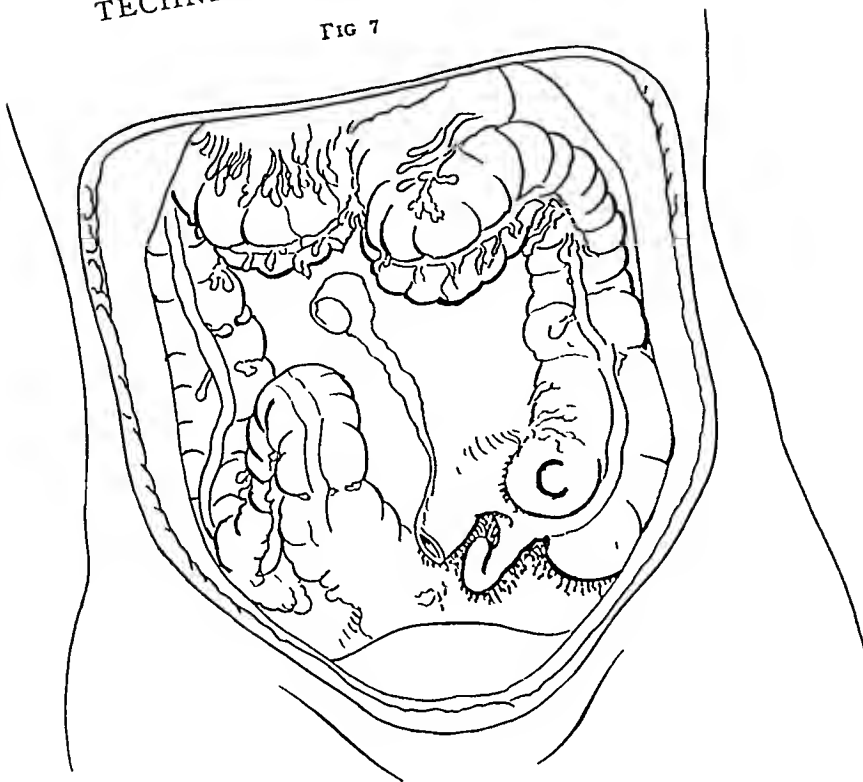
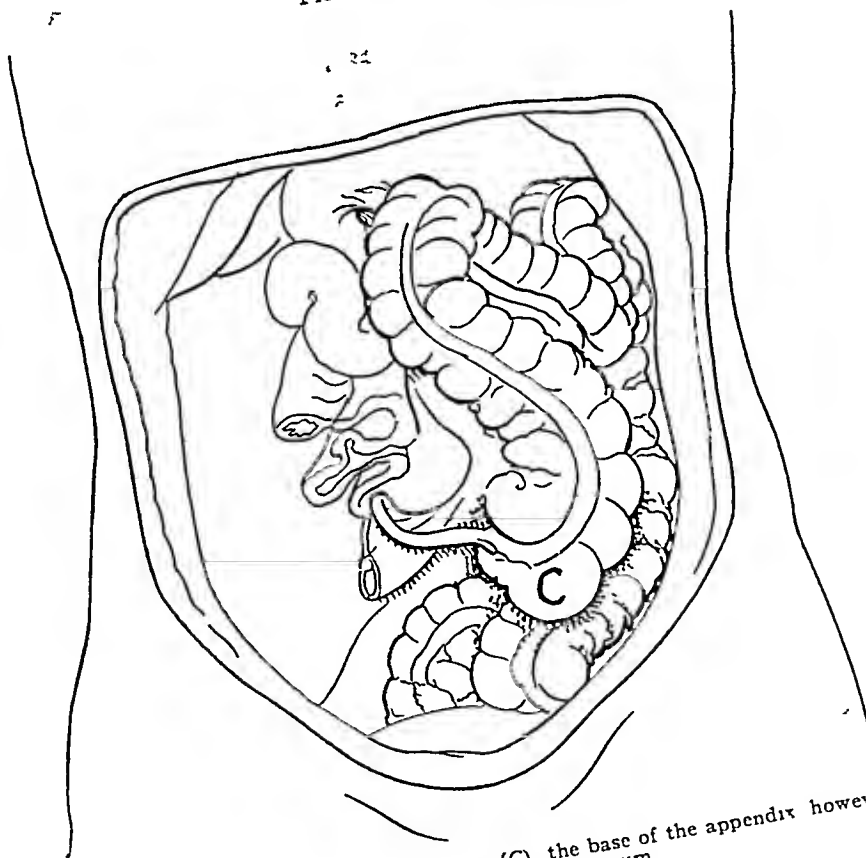


FIG 8



FIGS 5-8—Show the possible positions of the cæcum (C), the base of the appendix however has always normal relations with the cæcum

FIG 9

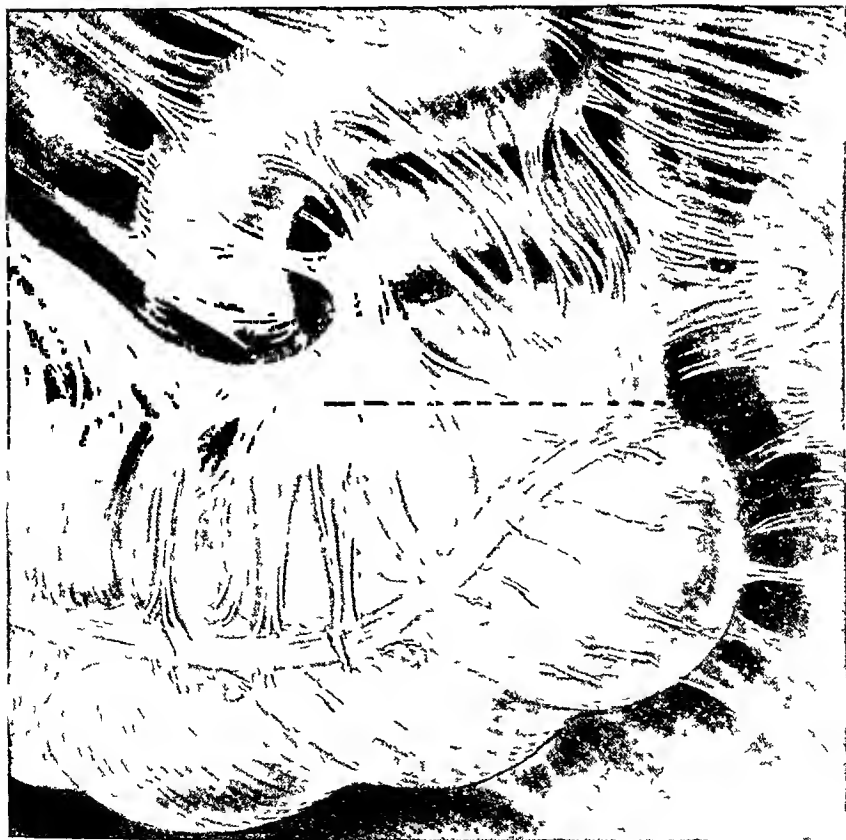
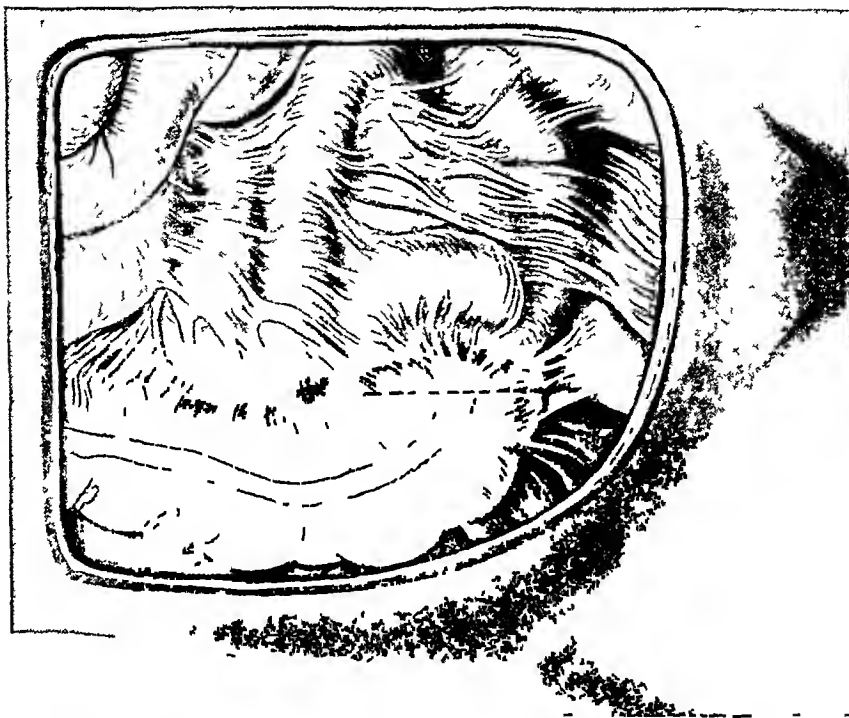


FIG 10



FIGS 9-10.—Schematic views of protective adhesions as found in cases of appendicitis. In Fig. 9 the perforated appendix is visible through the adhesions. In Fig. 10 the appendix is not visible. In both cases the omentum was removed to make the illustrations clearer, but evidently the omentum would also contract adhesions. Note that if the usual technic is followed in looking for the tip of the appendix, a number of valuable protective adhesions are broken when, instead, the surgeon follows our technic; the protective adhesions are not disturbed. Dotted lines show how pararectal incision falls on the base of the appendix.

wonder that some patients still die after appendectomy, and many complain of post-operative troubles. We believe that all surgeons will agree that in acute cases the protective adhesions built by the peritoneum must be preserved as much as possible, as the most valuable barrier against the spreading of infection. We can add, from a very exhaustive work on adhesions to be published soon, that all inflammatory adhesions do generally disappear completely a certain time after the inflammation has subsided, but that traumatic infected adhesions, resulting from the breaking of inflammatory adhesions, do not disappear as easily as the purely inflammatory ones, more often they become denser and thicker in the course of time, and might therefore be the cause of serious and dangerous complications. This point is exceedingly important, because if in acute cases of appendicitis the surgeon must be concerned in saving life, more than in anything else, it is logical to state that he should operate in such a manner that he should preserve all the coefficients that will help him in saving life and at the same time give good post-operative results, when these coefficients, as the protective adhesions, do help in saving life and giving satisfactory post-operative results.

Can the surgeon locate and remove the appendix without breaking the protective adhesions built by the peritoneum and without spreading infection, no matter what are the condition and location of the appendix? We answer yes, if the technic we advocate, and which is the opposite of the technic adopted nowadays, is followed. This technic is based on the following principles. First, *never look for the tip of the appendix which is difficult or impossible to find, but look only and in all cases for its base, which can be found very easily, safely and quickly.* Second, *keep away from the peritoneal cavity.* Third, *do not use protective pads, work always in the open, seeing exactly what you do and how you do it, knowing that it is exactly what you want to do and that it is done as you want it to be done.*

Locating the Appendix—Figs 11 and 12 show two schematic cross-sections of the right abdomen, corresponding about to the base of the appendix. A perforated appendix is surrounded by a collection of pus. A line divides the cross-section in two portions which are called safety-land and dangerland. Safetyland includes the two external thirds of the cæcum with the base of the appendix, dangerland includes the internal third of the cæcum and the general peritoneal cavity. In Fig 11 the appendix is located in the general peritoneal cavity, in Fig 12 the appendix is located under the cæcum, in both a perforated appendix is surrounded by a collection of pus. The parietal peritoneum, the cæcum, the omentum, and the loops of small intestine are adherent more or less firmly to each other (in these schematic illustrations the omentum and the adhesions were omitted in order to avoid any confusion and make clear the points we want to bring out). If the surgeon makes his incision as commonly done, loosens up the parietal peritoneum and the omentum on the side of dangerland and proceeds to locate and remove the appendix following

FIG 11

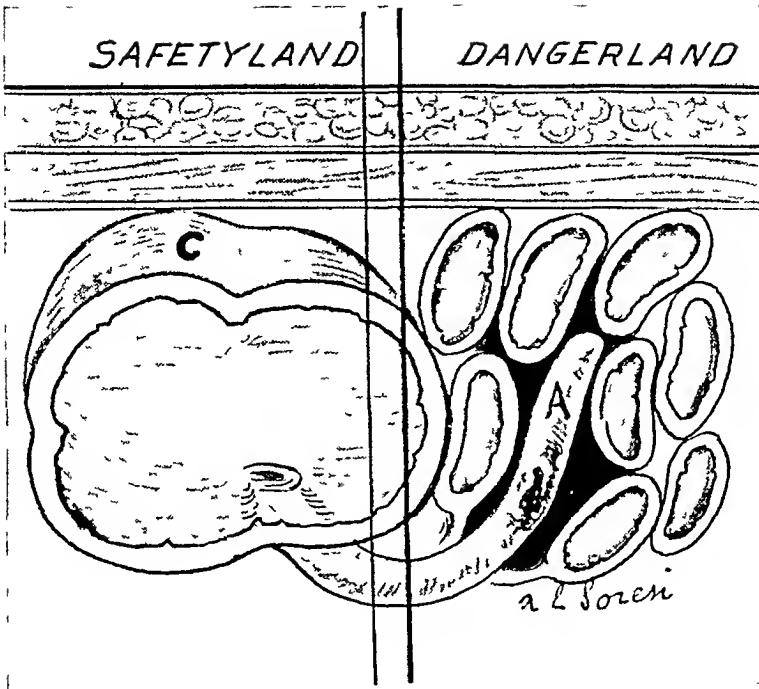
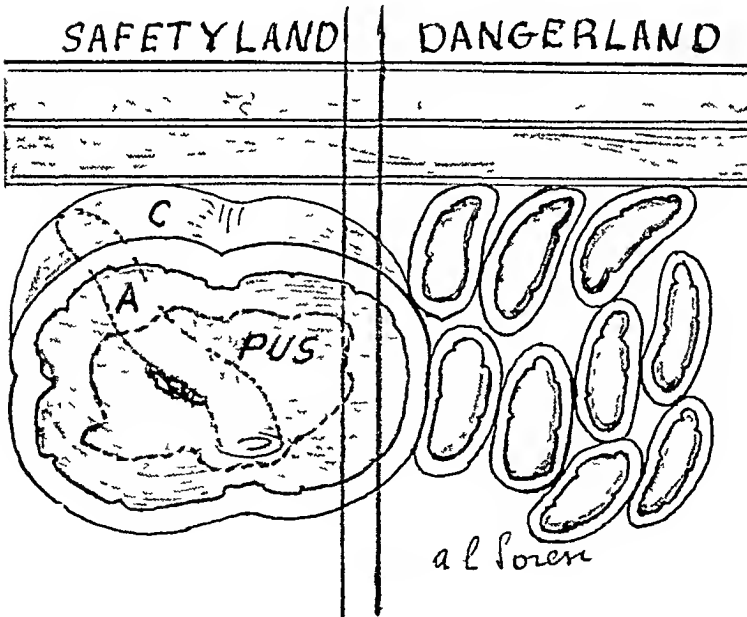


FIG 12



FIGS 11-12 —Schematic views of two typical perforated appendices with abscess formation showing that in both cases even if not diagnosed before operation by working only on the safety land the appendix can be easily removed without spreading the infection and proper drainage can also be applied

the actual technic adopted by many surgeons, even in the cases in which there is a superficial collection of pus, as represented in Fig 11, and when he is extremely fortunate in locating and removing speedily and without the slightest trouble the whole appendix, we repeat, even in absolutely the most favorable cases *he will positively have broken valuable protective adhesions and spread the infection to the parietal peritoneum, to the omentum, to the cæcum, to several loops of intestine, and around the ileocaecal valve and no one can know if the infection is not going to spread further*

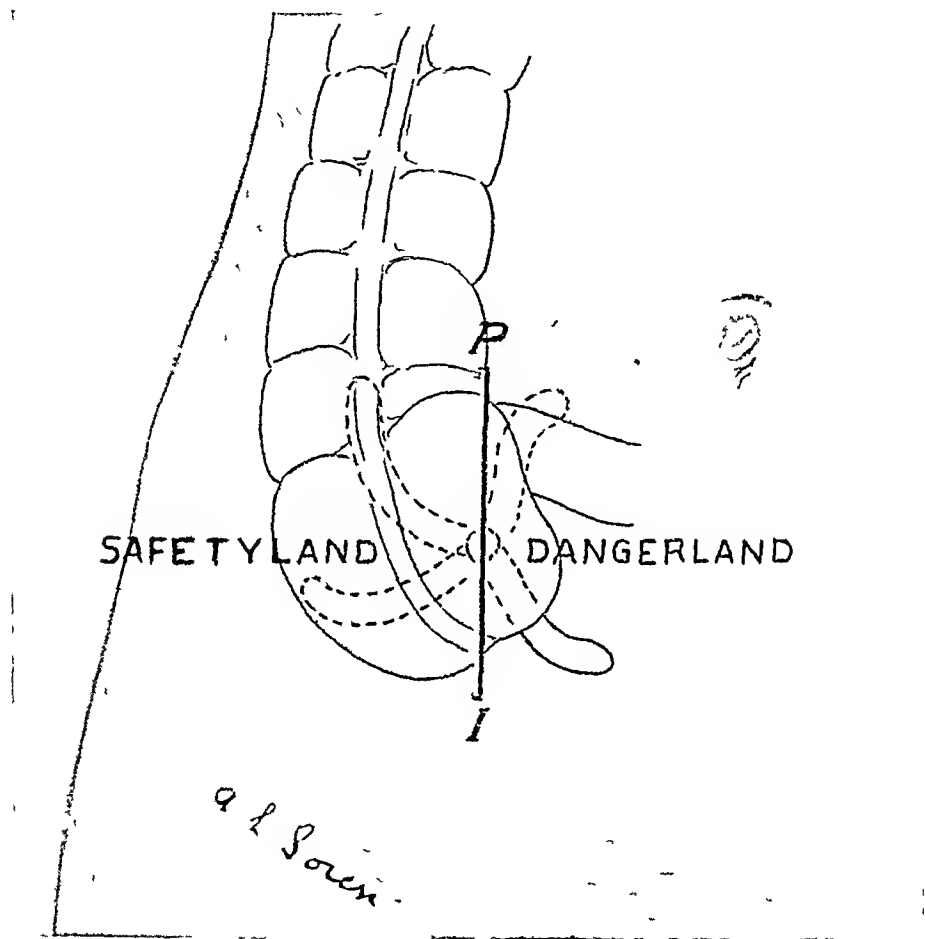


FIG 13 —Cæcum outlines on the abdominal wall showing how pararectal incision (PI) falls on the base of the appendix and on what side (safety land) the surgeon can work safely without breaking any protective adhesions (See Figs 9-12)

We took as an example the most favorable case, but suppose that the surgeon has to deal with a case where the continuity of the appendix is interrupted and its débris lost in the collection of pus (Figs 22 and 23), or with a case where it is difficult or impossible to locate the appendix, or the appendix is retrocæcal as shown in Fig 12, any one can easily imagine the damage he would cause by breaking numberless valuable adhesions and spreading the infection, who knows how far

It is not uncommon to see surgeons who are dealing with so-called bad acute cases, remove only a portion of the appendix and then close the

base as well as possible under the circumstances, or not even attempt closure at all, but limit themselves to putting in a drain and hope in good luck (Fig 22) This procedure is due to the fact that when adhesions and pus are present and the patient is not in good condition, the surgeon rightly feels that he has to get out of the abdomen as rapidly as possible, he finds it difficult or more often impossible to horizon himself, knows that to try to locate the appendix means the breaking of numerous

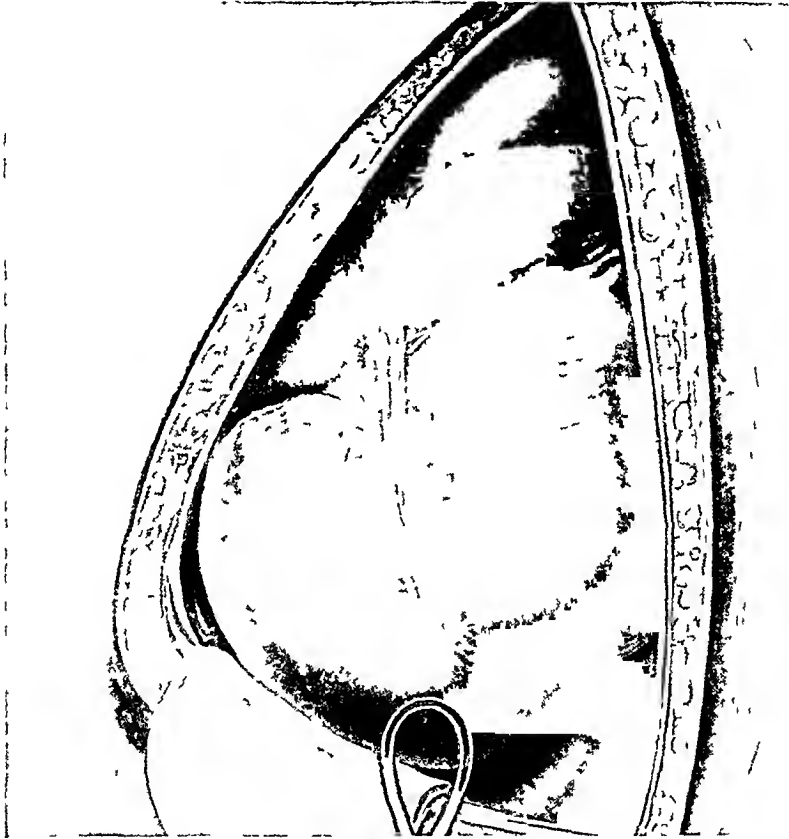


FIG 14 —Shows how and where to apply blunt retractor in order to expose cæcum and where to apply sponge holder (which must be covered with rubber) to cæcum in order to expose base of appendix (See Fig 15) Adhesions have been omitted to make the illustration clearer

protective adhesions, and therefore feels compelled to resort to what must be called, at best, a makeshift Could any one feel satisfied with such work done to himself, if he should need an urgent appendectomy?

Let us see how the technic we propose *for all acute cases can take care of any condition the surgeon might meet most unexpectedly* We never use the small McBurney incision, but use an incision that will lead us to the internal third of the cæcum which corresponds to the base of the appendix (Figs 1, 2, and 13), therefore, we make a pararectus incision beginning a couple of centimetres below the umbilical line and extending

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downwards about eight or ten centimetres (Fig 13) When the peritoneum is reached it is freed from probable adhesions binding it to the cæcum, *but only on the external side, we do not, for any reason, even touch the internal edge of the peritoneum, much less try to free it from any adhesions binding it to the cæcum* We keep always outside of the border between safetyland and dangerland, raise up the peritoneum and apply a

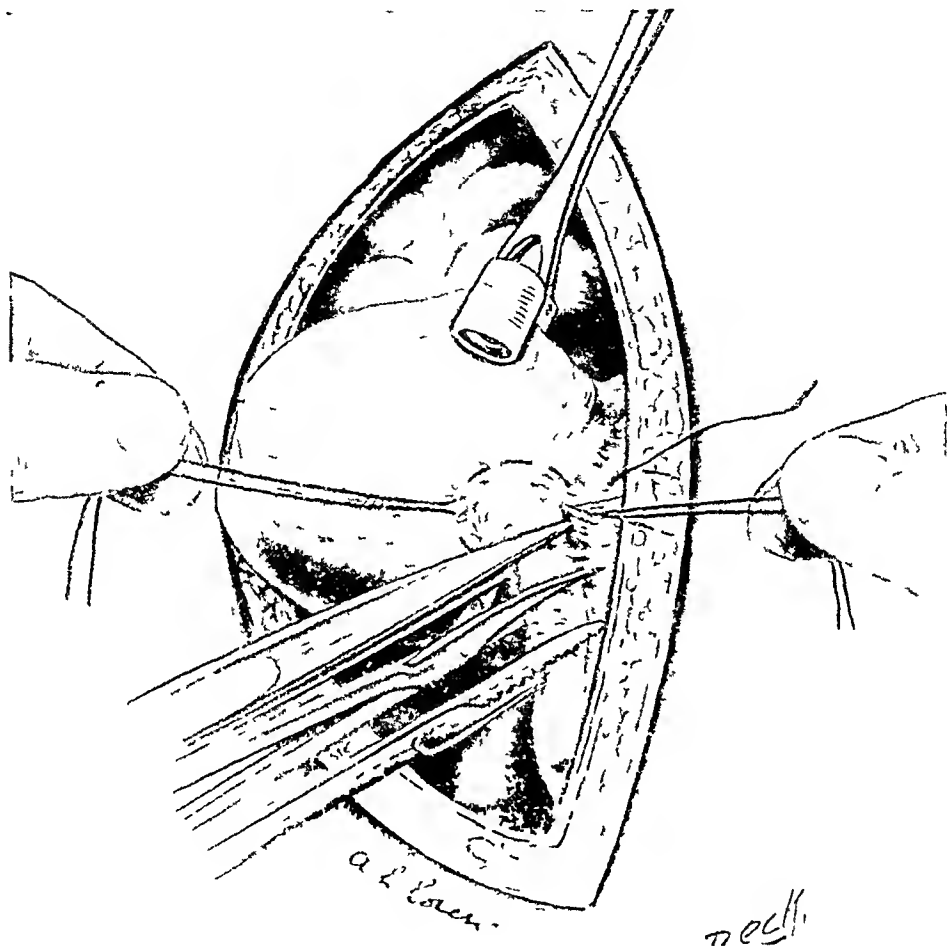


FIG 15 —The two outer thirds of the cæcum have been freed from adhesions and lifted up inwardly, the base of the appendix freed from adhesions and exposed, the special purse string suture applied, the assistant holds the four threads forceps are applied and the appendix severed (The appendix was exposed quite freely and the instruments forceps and scissors were put wide apart from each other in order to render the picture clearer In actual work it is only necessary to expose about one centimetre of the appendix and the appendix must be cut close to its base, the two forceps should be put so close as to leave only room for a thin pair of scissors to cut through between them)

blunt retractor to the outer edge of the incision close to its lower angle (Fig 14), and raise up the cæcum with a soft sponge-holder covered with rubber applied to its lower external portion (Figs 14 and 15) Naturally the cæcum must be freed from occasional adhesions Do not apply any pads and do your dissection preferably with sharp instruments, making hæmostasis as you proceed by tying in small masses with the finest plain catgut the tissues that might bleed Even in the worst cases the liberation of the outer portion of the cæcum is not difficult, because there is no

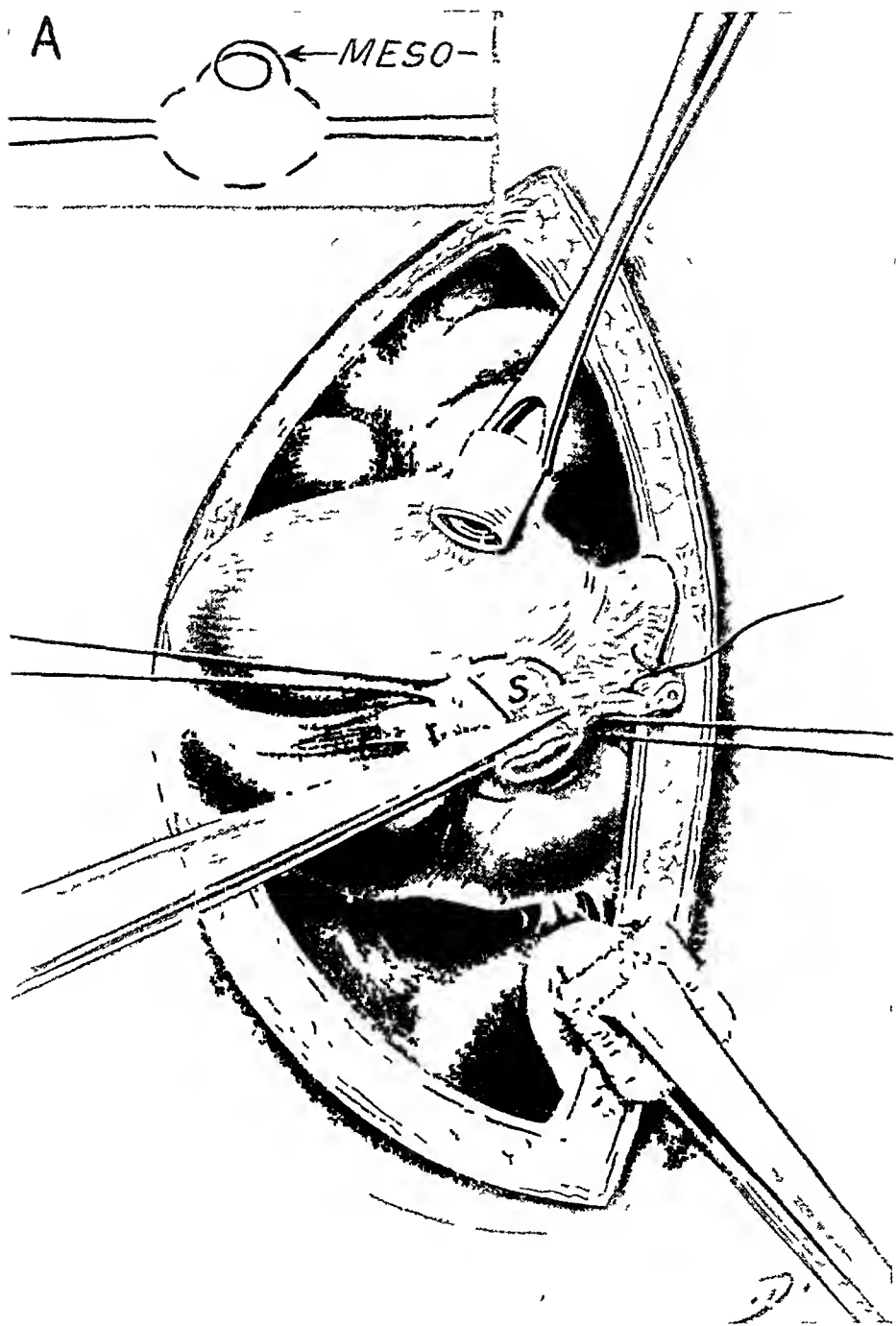


FIG 16 —The appendix has been cut close to its base the distal portion covered with gauze and secured with a Museux or other suitable forceps. The base of the appendix is slit within the line of suture (S) in case the cæcum and appendix are very thick. Sketch A shows how to secure hæmostasis of the appendicular blood vessels without resorting to tying the meso separately.

other organ in contact with the cæcum and so there is no danger of injuring anything but the cæcum itself, and injury to the cæcum can be avoided easily by any good surgeon. Once the cæcum is raised up the base of the appendix will be seen very easily, free gently about one centimetre of the appendix from adhesions, if necessary, and surround its base with a purse-string suture made with plain catgut No 0 or 1 entering the lumen of the gut (Fig 15). At half suture the catgut forms a loop about ten centimetres long, and then the suture is completed. The catgut loop is cut and then the assistant takes hold of the four threads and with their help lifts up the base of the appendix (Fig 15), the meso-appendix can either be tied and cut between two ligatures, or can be disposed of by

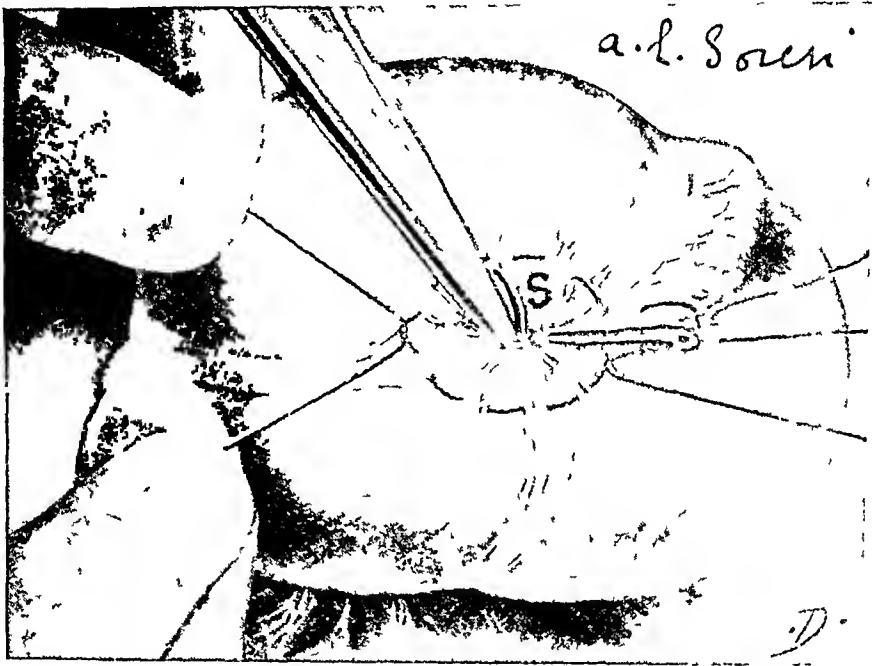


FIG 17 —Inversion of stump of appendix in the cæcum—while assistant holds the forceps and two threads the surgeon ties the other two threads

passing behind it the catgut that is used to make the purse-string suture, as shown in the sketch attached to Fig 16 (A), and pulling the thread taut over the meso, the distal portion of the appendix is clamped, the surgeon catches with a thumb forceps the base of the appendix and severs it with scissors (Fig 15), the assistant holds temporarily the thumb forceps with either hand while always holding the four threads, the surgeon quickly covers the cut end of the distal portion of the appendix with a piece of gauze kept in place by a Museux or other suitable forceps, drops it temporarily (Fig 16), and inverts the stump of the appendix into the cæcum, while the assistant holds the cæcum itself by means of the four threads (Fig 16). If the cæcum is very thick a slit can be made in its wall within the purse-string suture (Fig 16) so that in all cases the inversion of the stump of the appendix is made not only possible but very



FIG 18 —Inversion of stump of appendix completed forceps are removed, the other two threads are tied

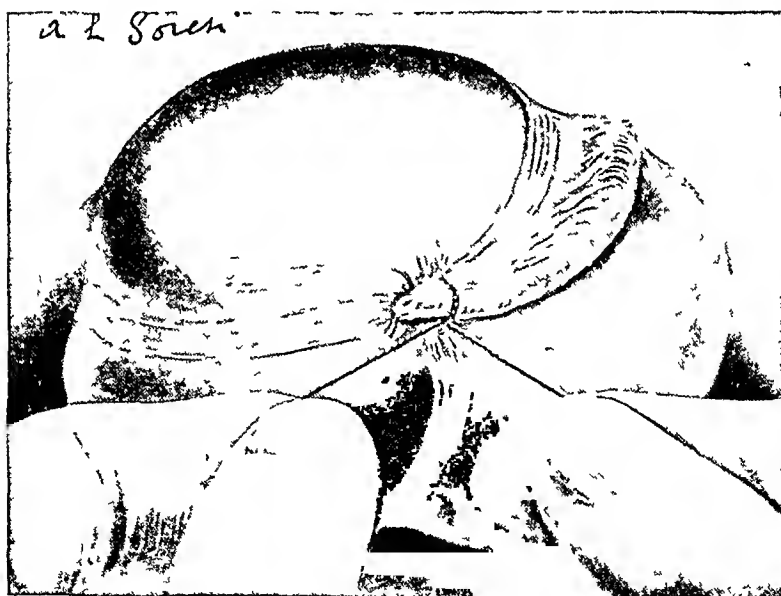


FIG 19 —Area from which stump of appendix was removed is covered when possible with meso appendix

easy The assistant passes two of the four threads to the surgeon, and with the hand that he has free takes hold of the thumb forceps, the surgeon pulls the threads rather taut and ties them, while the assistant holds steadily the opposite two and the thumb forceps (Fig 17), then the surgeon takes hold of the other two ends of the threads, pulls them very

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taut and ties them (Fig 18), while the assistant removes gently the forceps, the inversion of the stump of the appendix is completed, if there was a long meso-appendix it can be brought over the area where the



FIG 20 —Surgeon takes hold of distal portion of appendix (A) and frees it from adhesions

stump has been inverted by tying together one of the threads used in the purse-string suture and one end of the thread used in tying the meso (Fig 19)

The surgeon now takes hold of the Museux or any other clamp used to catch the distal portion of the appendix and proceeds to free the

appendix itself from the adhesions that surround it. The liberation of the appendix is done with the help of scissors which alternate sharp and blunt dissection according to circumstances (Figs 20 and 21), while hæmostasis is made whenever it is necessary, if the dissection is properly made bleeding will be practically nil. It is evident that the liberation of the appendix is easy, because the surgeon has only to follow the appendix itself, and this can be done without disturbing the protective adhesions, because the only portion of the adhesions which is disturbed is the layer

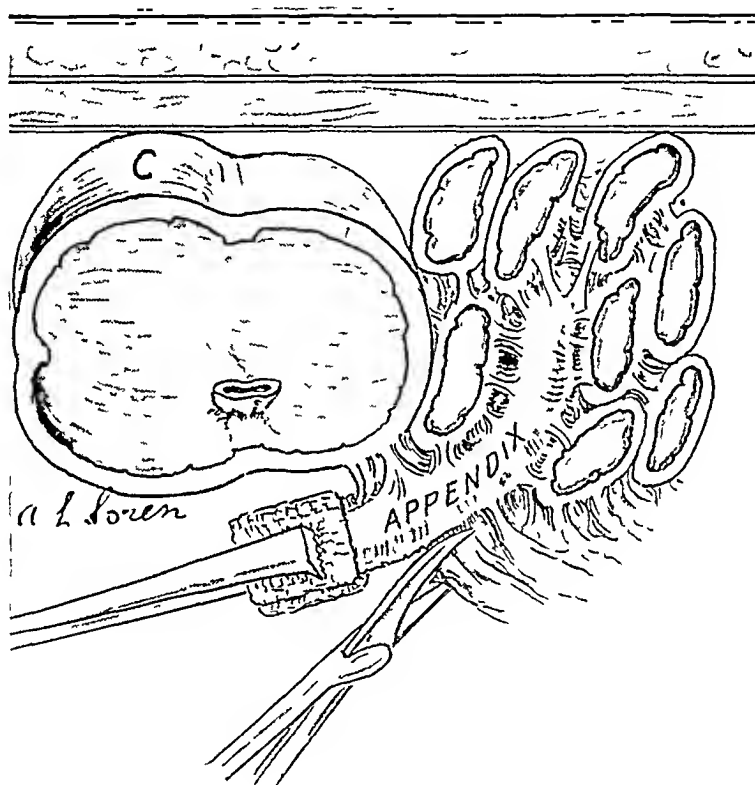


FIG. 21—Schematic cross section showing how freeing the appendix is easy and can be accomplished without breaking any protective adhesions even in the worst cases when the freeing is done as recommended in the paper

that is in immediate contact with the appendix, so that the other peritoneal organs are never touched or even disturbed.

There are cases where the finding and removal of the whole appendix would be next to impossible without causing so much trauma and diffusion of infective material as to be fatal to the patient. These are the cases where the continuity of the appendix is interrupted by gangrene and the debris of the appendix are lost in what might be a limited abscess or among more or less firm adhesions that result from a more or less diffused peritonitis. In these cases the superiority of the technic we recommend becomes very plain. Indeed, when the usual technic is followed the most

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valuable adhesions, that is, the adhesions between the parietal peritoneum and the line between safetyland and dangerland, are broken as the first step in locating the appendix, so laying open the peritoneal cavity, but this is not the only and gravest danger. Indeed, even if after having broken numberless valuable adhesions and spread infection, the surgeon finally succeeds in finding and removing the tip of the appendix he might not be able to get at the base, as stated before, and therefore a dangerous condition results. Fig 22 shows that the tip of the appendix has been

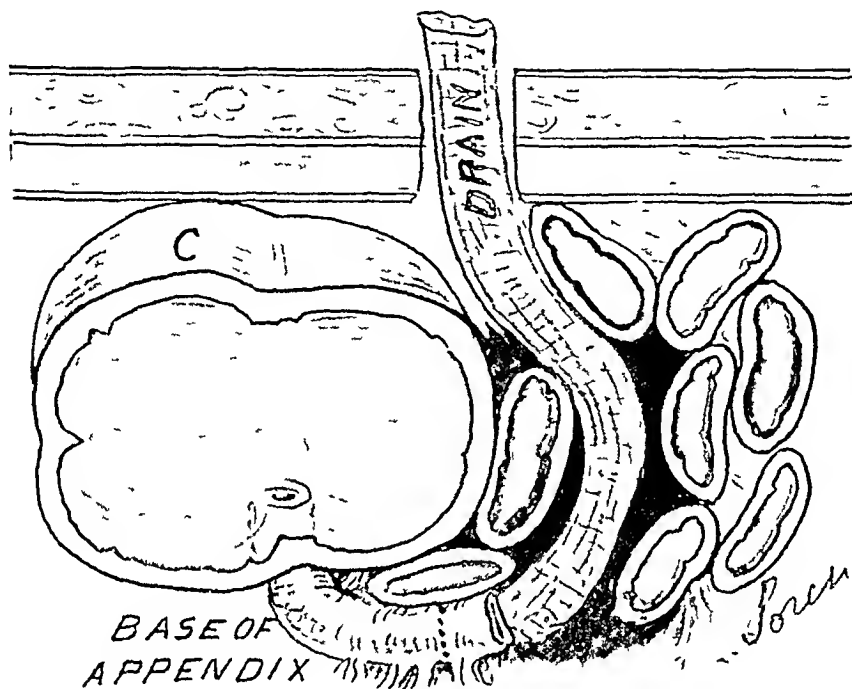


FIG 22 —Schematic cross section showing what dangerous condition may arise when the base of the appendix is not secured and only the tip is removed as it happens when the appendix is gangrenous if the ordinary technic is followed. Protective adhesions have been broken the appendix might be left open or badly tied on dotted line and pour septic material into the abdomen. an irrational drainage is applied, result general peritonitis and death or fecal fistula sloughing of tissues hernia necessity of secondary operation in the fortunate cases

removed, but the proximal portion is lost in the debris that formed around the gangrenous appendix. Fig 23 shows instead that the proximal portion of the appendix has been removed and its opening in the caecum sealed, but the tip of the appendix is left in the abdominal cavity. Which is the most dangerous condition, the one represented in Fig 22 or the one represented in Fig 23? In the condition represented in Fig 22 we see that numerous valuable defensive adhesions have been broken the peritoneal cavity is open to infection, and the caecum is in direct communication with the peritoneal cavity into which septic material will be poured, so that general peritonitis will ensue, or in the fortunate cases a fecal fistula will form. In the condition represented in Fig 23 we have not opened the general peritoneal cavity, we have done practically an extraperitoneal

operation, but the tip of the appendix is left in. Can its presence constitute an actual danger?

We can answer that if proper drainage is instituted there is absolutely no danger in not removing the tip of the appendix, on the contrary, it would be extremely dangerous in some cases to even attempt to locate it. In fact, if the technic which we have described above is followed, the cæcum is completely and securely closed in all cases, then the appendix is followed and freed, if in doing so the surgeon reaches an area where there is pus, and the appendix is lost in it, he has only to institute a proper drainage in order to feel sure that he has done the proper thing.

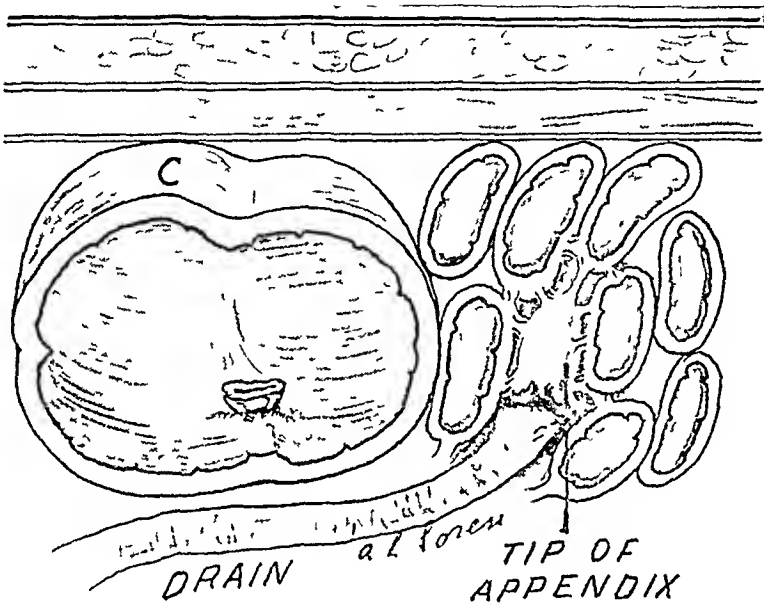


FIG 23—Compare this cross section with the one shown in Fig 22. Here we suppose the same gangrenous appendix; the base of the appendix was secured first; the tip could not be removed and is left in. No danger, the tip will be partly eliminated and partly absorbed; it is possible to apply a rational drainage; result: no protective adhesion broken; life saved; no fecal fistula; no sloughing of tissues; no hernia; no necessity of secondary operation.

for his patient. Indeed, the tip of the appendix is practically dead tissue, and having no communication with any other organ and no blood supply, must fall in complete gangrene and slough off. Therefore, if proper drainage is instituted the sloughing of the tip of the appendix will not be dangerous, because the products of its disintegration will partly be carried out with the other debris of tissues, and partly completely surrounded by protective adhesions, and so finally absorbed. If any attempt is made to locate and remove the tip of the appendix valuable protective adhesions will be destroyed, the infective process diffused, and the safety of the patient greatly endangered. We have, however, stated that proper drainage must be instituted and we must emphasize this most important point.

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The Drainage of the Infected Area—In dealing with drainage of the abdominal cavity we have to take into consideration the following facts. The peritoneum reacts very promptly and energetically against infective agents and foreign bodies by isolating them with adhesions which will be more valuable and more rapidly formed the stronger is the resistance and vitality of the peritoneum and the more irritating is the infective agent or foreign body. It is therefore ridiculous to insert a piece of gauze or a rubber tube in the abdominal cavity and take it out through the laparotomy wound with the hope that all the septic material will be drained out, such a drain will only irritate the peritoneum, which when in good condition will set up strong and valuable adhesions, when, on the contrary, it has been badly infected and traumatized, it will react very poorly and not set up immediately valuable adhesions, so that the presence of the gauze or tubes will only help in the diffusion of the septic process. *A drain put between peritoneal organs can only carry out material that is collected in a cavity limited by adhesions, but can never drain the general peritoneal cavity*, because, as we stated, when the peritoneum is in good condition it builds up immediately adhesions that will limit the infective process, when in poor condition and not able to build up a valuable defense, the spreading of infection will not only not be prevented by the drainage, but in many cases the drainage itself might be a strong coefficient in spreading infection. We insist on this fact, because the secretions that collect in gauze or drainage tubes are a good culture medium for the microorganisms which will be protected against the active action which the peritoneum would set up against them, because they are embedded in the meshes of the gauze or inside of the tube. We shall not discuss all the points relating to drainage of the abdominal cavity, because it would take many pages and we have dealt with it in many articles, we will only state that it is irrational to drain with gauze, cigarette drains, or tubes put in the abdominal cavity and brought out through the laparotomy wound. They are irrational and dangerous, because they help the infective process, they infect the laparotomy wound, so predisposing the patient to post-operative hernia and might cause serious trouble by their presence, and finally they do not actually drain. This last point needs a special mention. Liquids can only come out of a cavity when they fall out of it by gravity or are pushed out by pressure (Fig. 24), a drain put in the abdomen through the laparotomy wound evidently cannot drain by gravity, can therefore only drain when the liquid is under pressure, which means that there must be a certain accumulation of liquid which is pushed out by the pressure exercised upon it by the walls of the cavity in which it is enclosed, the absurdity of such a condition does not need to be emphasized. Gauze and cigarette drains are supposed to drain by capillarity, but it is sufficient, as we have demonstrated in other papers, to think that pus is a suspension of corpuscles that will immediately occlude the tubules that constitute the

capillarity of the gauze, to understand that capillary drainage of organic liquids, as dense as pus, is a physical impossibility. *The first and most important factor for effective drainage of the peritoneal cavity is the preservation of the adhesions which the peritoneum has built up in order to limit the spreading of the infective process, no matter how thin and delicate these adhesions are.* We repeat we can only aim to drain the cavity that has been limited by adhesions, this cavity will shrink and finally become occluded if the process of repair on the part of the peritoneum is not hampered by the work of the surgeon. This is the reason why we have been so careful in limiting the dissection of the appendix from the adhe-

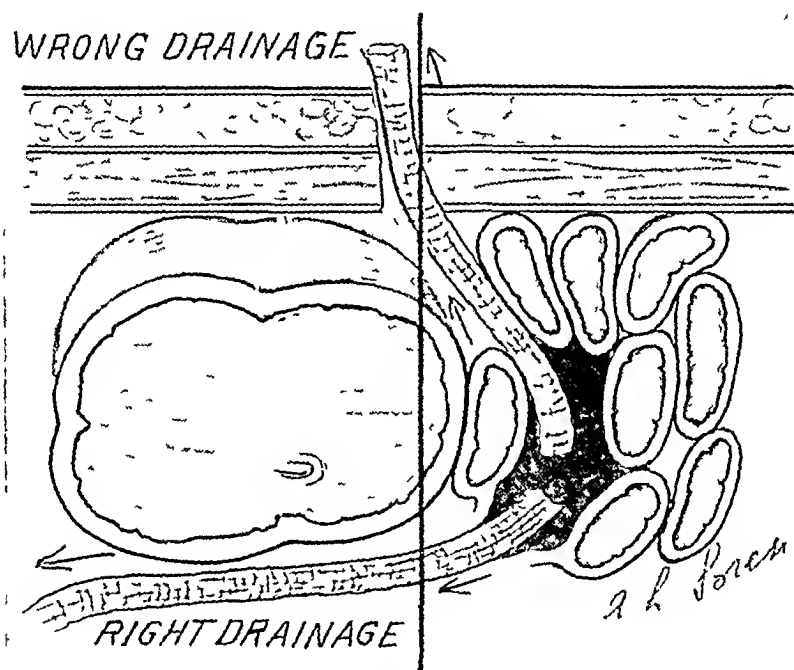


FIG 24 —Schematic cross section showing right and wrong manner of draining a collection of pus. The right drainage drains by gravity; the wrong does not drain because liquid cannot climb uphill and therefore is irrational.

sions that surround it. Next in importance is that drainage has to follow the law of gravity (Fig 24), therefore, the drainage has to be carried out through a stab wound made in the most dependent portion of the region to be drained, in cases of appendicitis a stab wound in the flank will serve the purpose, in the woman when the appendicular abscess is contiguous to an abscess around the adnexa, a stab wound through the cul-de-sac of Douglas is advisable and to be recommended (Fig 26). Third, the means used as drainage should really drain and should not cause any complications that might be due to its presence. Glass and rubber tubes are therefore most dangerous, especially on account of the fact that they may cause pressure gangrene.

The ideal drainage is constituted by strips of gauze dipped in melted

paraffine and properly placed Gauze covered with paraffine constitutes the ideal drainage, because to paraffine nothing adheres, so that between the paraffinated gauze and the tissues there will be always a space through which the pus will drain out by gravity (Fig 24), paraffinated gauze adapts itself to the organs to be drained, does not irritate them, and obviously constitutes a solid body that cannot harbor any microorganism, paraffinated gauze does not need to be changed, thus avoiding any trauma or secondary infection due to introduction of a new drain The

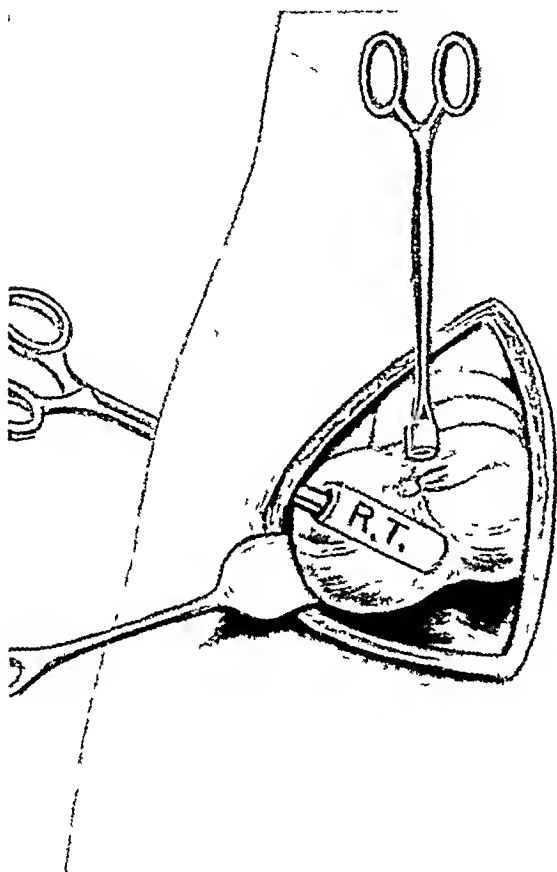


FIG 25 —Manner of applying the paraffine gravity drainage R T rubber tube paraffinated passing through a stab wound in the flank the tube should not extend into the abdominal cavity but only pass through the abdominal wall

gravity drainage has the other immense advantage of allowing a complete perfect closure of the laparotomy wound, even in the most infected cases, as explained later, so preventing post-operative hernias

The paraffine gravity drainage is applied as follows One or more strips of gauze about two centimetres wide are dipped in melted paraffine and allowed to stiffen, if a cavity with pus is met and when the tip of the appendix can not be removed, a strip of the paraffinated gauze is put in immediate contact with the cavity to be drained and can be secured in place by a stitch of thin catgut tied with only one knot (Fig 25),

it is brought under the cæcum and out through a stab wound made as far back in the flank as possible (Figs 25 and 26) The stab wound through the flank is lined with a rubber tube (Fig 25) that has also been dipped in melted paraffine, and which should not itself extend into the peritoneal cavity, but should go only through the skin, muscles and fascias (Fig 25) The paraffinated gauze is brought out through the rubber tube, this is done because the muscles at times contract so energetically that they

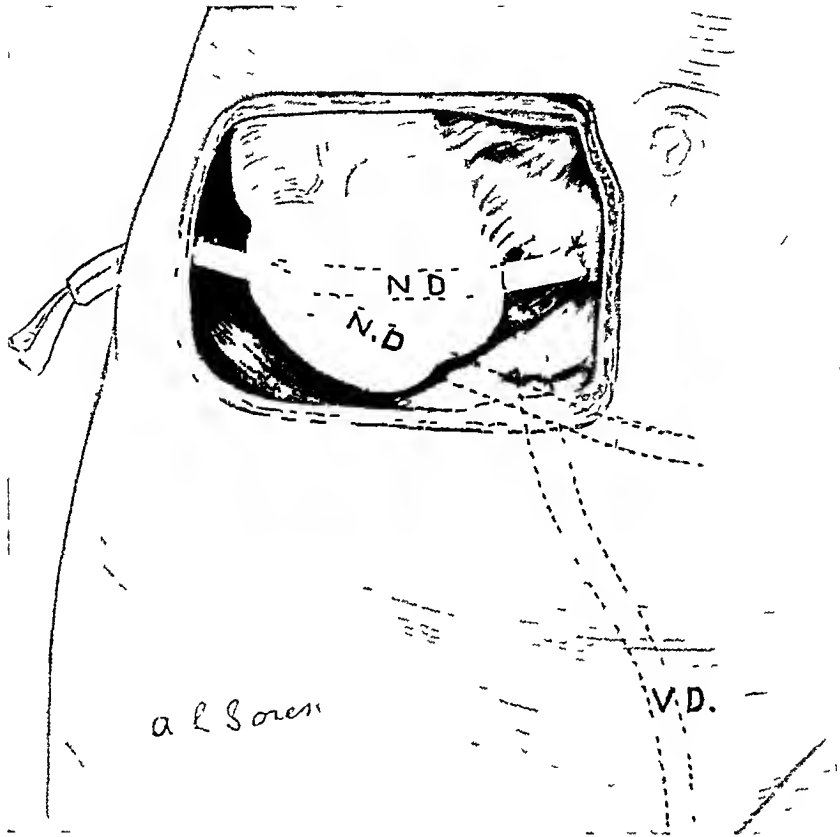


FIG 26 —Paraffinated strips of gauze put exactly on the spot to be drained and brought out in normal drainage (N D) through the rubber tube in certain cases they may be brought out through the cul de sac of Douglas (V D) (Note that the drain is held in position by a stitch which however should be made with very fine catgut and tied with only one knot) (See Figs 21 23)

completely occlude the space between the gauze and the tissues, occlusion that is helped also by the drying of the secretions on the skin around the gauze when the secretion is not abundant, all these drawbacks are eliminated by placing a paraffinated rubber tube in the abdominal wall and having the gauze come out through it (Figs 25 and 26) Naturally, if two or more collections of pus are to be drained, two or more strips of gauze are used and brought out through a single tube (Fig 26) Drainages are shortened and finally removed according to circumstances

Pararectus Incision and Drainage of Abdominal Wall—We advise the

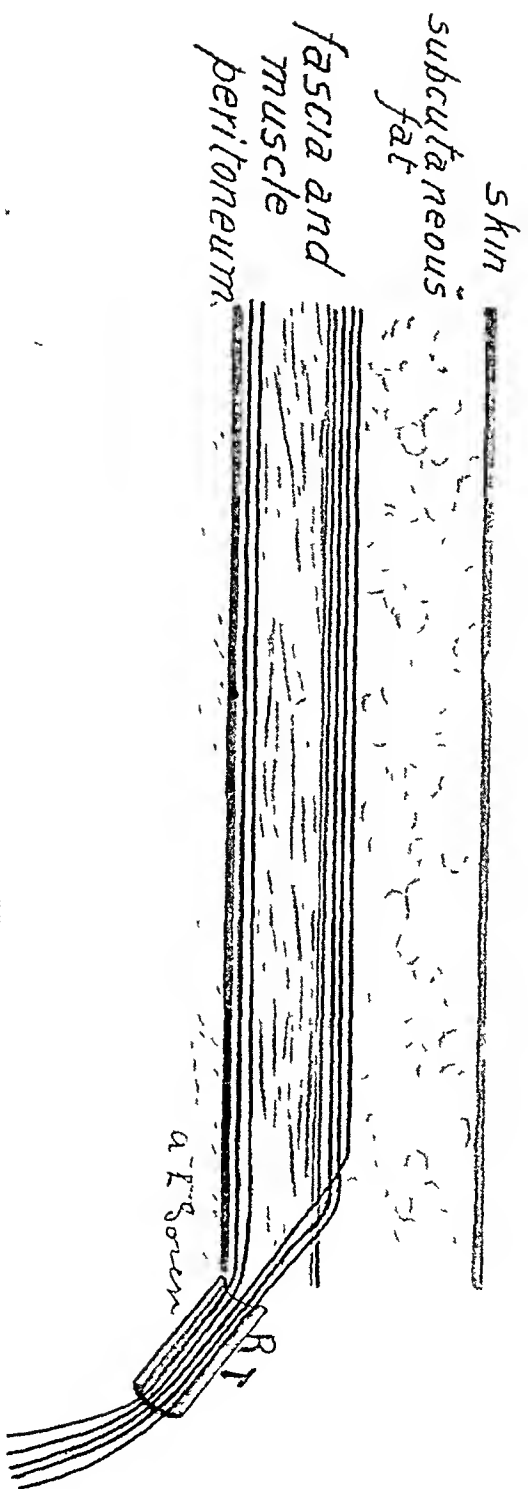


Fig. 27—Schematic cross section of drainage of abdominal wall. Paraffinated threads are applied over peritoneum and fascia and brought out through R.T., a paraffinated rubber tube. Note that drainage is accomplished only by gravity, stab wound being in a more dependent position than laparotomy wound (see Fig. 28)

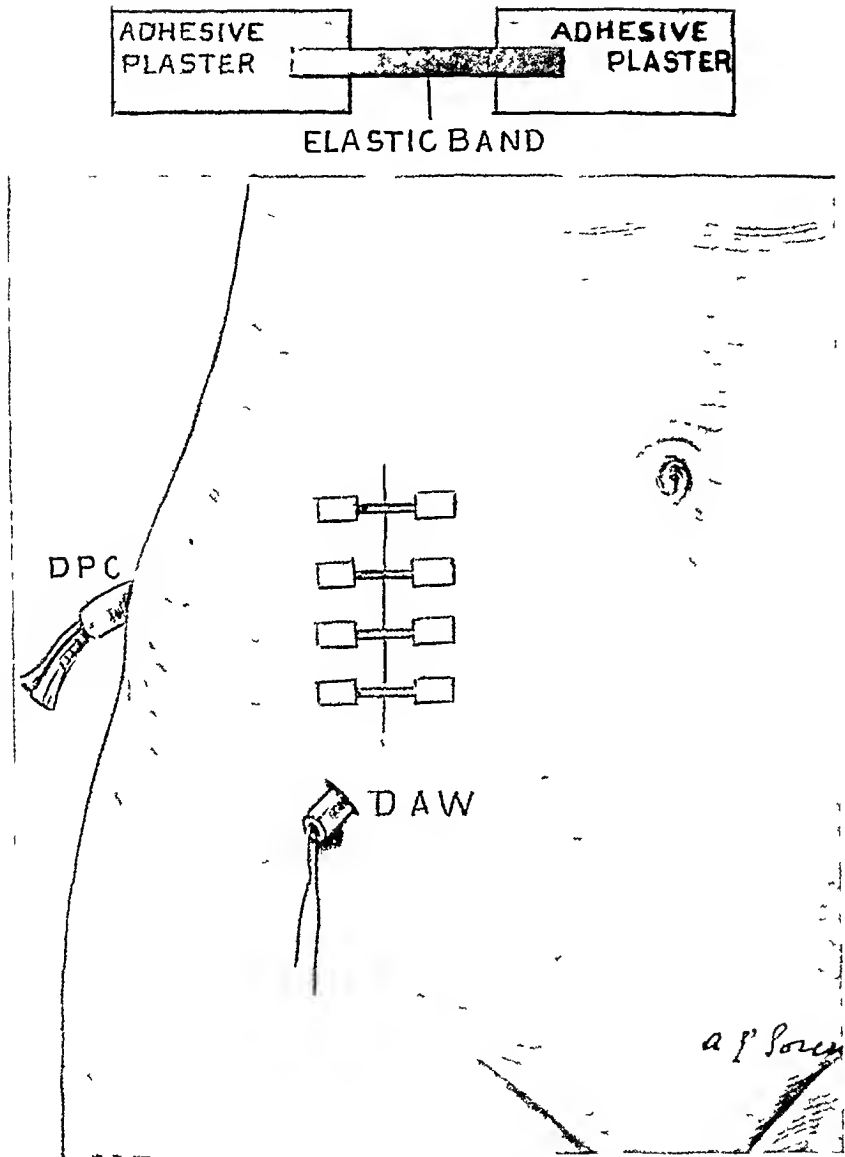


FIG 28 —Shows abdomen closed and drains applied. Abdominal wall is closed with two rows of sutures the skin is approximated with elastic bands that give practically a scarless union. D P C drainage of peritoneal cavity D A W drainage of the abdominal wall this drainage will prevent post operative hernia (See Fig 27)

para-rectus incision, because it falls on the cæcum, can be extended freely and allows the extraperitoneal removal of the appendix better than any other incision. By following the technic we have advised infective material will very seldom touch the abdominal wall, so that post-operative hernia will be prevented more often than when this technic is not followed.

We make a longer incision than is usually made, because we believe that a good exposure of the abdominal organs is most essential to good abdominal surgery, and by draining systematically with our paraffine gravity drainage the abdominal wall (Fig 26) and the elastic closure of the same as shown in Fig 28, post-operative hernia is practically completely eliminated, even in the most infected cases. The peritoneum is closed in the usual manner and over it are laid two or three heavy threads that have previously been dipped in paraffine and are carried out through a stab wound made anteriorly and outwardly to the lower limit of the skin incision, the muscles and fascia are then sutured and three or four paraffinated threads are laid over the sutured structures and brought out through the same stab wound through which the other threads have been carried out. The stab wound is lined with a small rubber tube previously dipped in melted paraffine, as was done and explained for the stab wound in the flank (Figs 25 to 28), and all the threads are carried out through it. The skin is not sutured but approximated with elastic bands made of two strips of adhesive plaster and a piece of rubber band, this arrangement insures a better closure of the skin which results in practically an invisible scar and does not favor the dissolution of the fat found in the abdominal wall. We close all laparotomy wounds in this manner, because the drainage and the elastic closure insures a primary union even in the infected cases, and this is very important, especially in cases of acute appendicitis, because the laparotomy wound has a great tendency to suppurate, even in clean cases.

Interval Cases —In the interval cases appendectomy is performed following the same technic that we use in acute cases, except that when the appendix is free and visible we catch its tip with a soft sponge-holder covered with rubber, as shown in Fig 29, and the removal of the appendix is the first instead of the last step.

Disposal of the Stump at the Base of the Appendix —The importance of the problems relating to the disposal of the base of the appendix is due to these facts: septic material can be poured into the abdominal cavity from the opening existing between the appendix and the cæcum, the blood supply to the whole appendix comes from the blood-vessels at the base of the appendix, except in women, when occasionally a supplementary blood supply comes from the broad ligament. These facts emphasize the absolute necessity of properly disposing of the stump of the base of the appendix, if this is not done the septic material coming from the cæcum will either cause a general fatal peritonitis, or in the lucky cases a fecal fistula, fatal hemorrhage might result if hæmostasis of the blood-vessels of the base of the appendix is not properly insured. These facts show plainly that the surgeon must, when possible, close the appendix at its base, and insure perfect hæmostasis. Which is the best manner of securing both these desiderata? Obviously, if the technic we have advised is followed, the inversion of the stump of the base of the

appendix being the first step, this step will be properly attended to in all cases, if the tip of the appendix is looked for as the first step, the proper disposal of the stump of the base of the appendix might not be possible, as explained above. We have, however, to justify why the inversion of

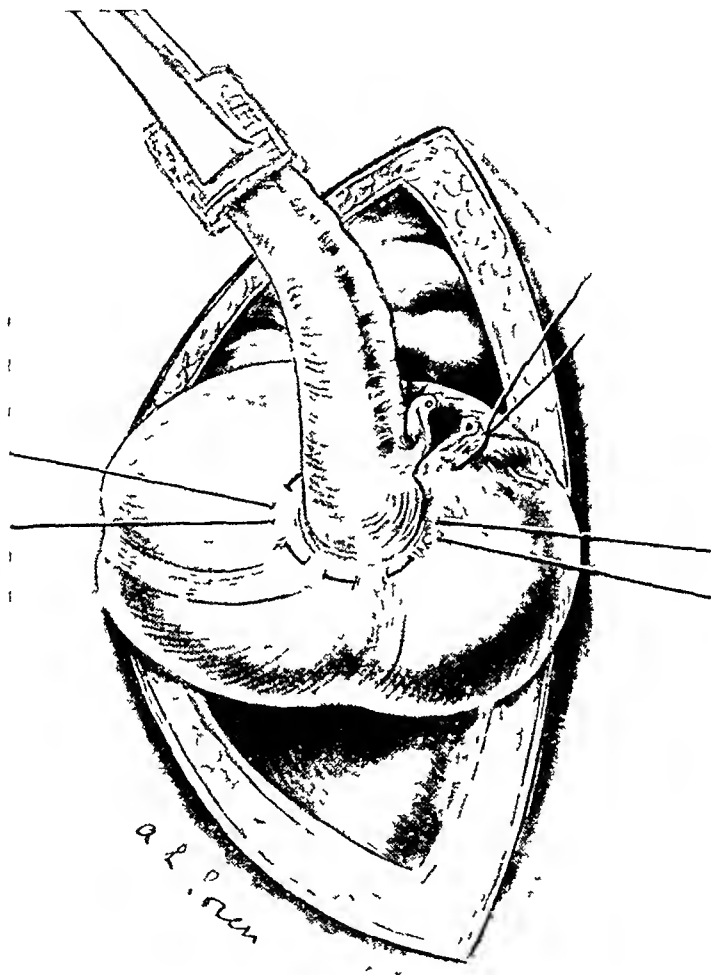


FIG. 29.—Manner of removing appendix in interval cases when no adhesions are present. All the other steps are illustrated in Figs. 15-19.

the stump of the base of the appendix, as we advise, is better than ligation and inversion or simple ligation.

Inversion of the Stump of the Base of the Appendix Without Tying It—Following the technic we have described the thread enters the mucosa. Is it safe and indispensable to do so? Yes, the thread can safely enter the mucosa, as there is no reason to fear a more severe infection from the thread if it goes through than if it does not do so, because the whole wall of the gut is already permeated with microorganisms, and anyhow, the

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whole thread will immediately be buried under a deep layer of inverted serosa, which will adhere immediately (Fig 30*B*) It is indispensable to penetrate the lumen of the gut, otherwise fatal hemorrhage might ensue, because the blood-vessels of the gut run into the submucosa, and therefore would not be closed if the suture should penetrate only the serosa, as was recommended by Dawbarn

It is easy and safe to invert the stump of the appendix if our technic

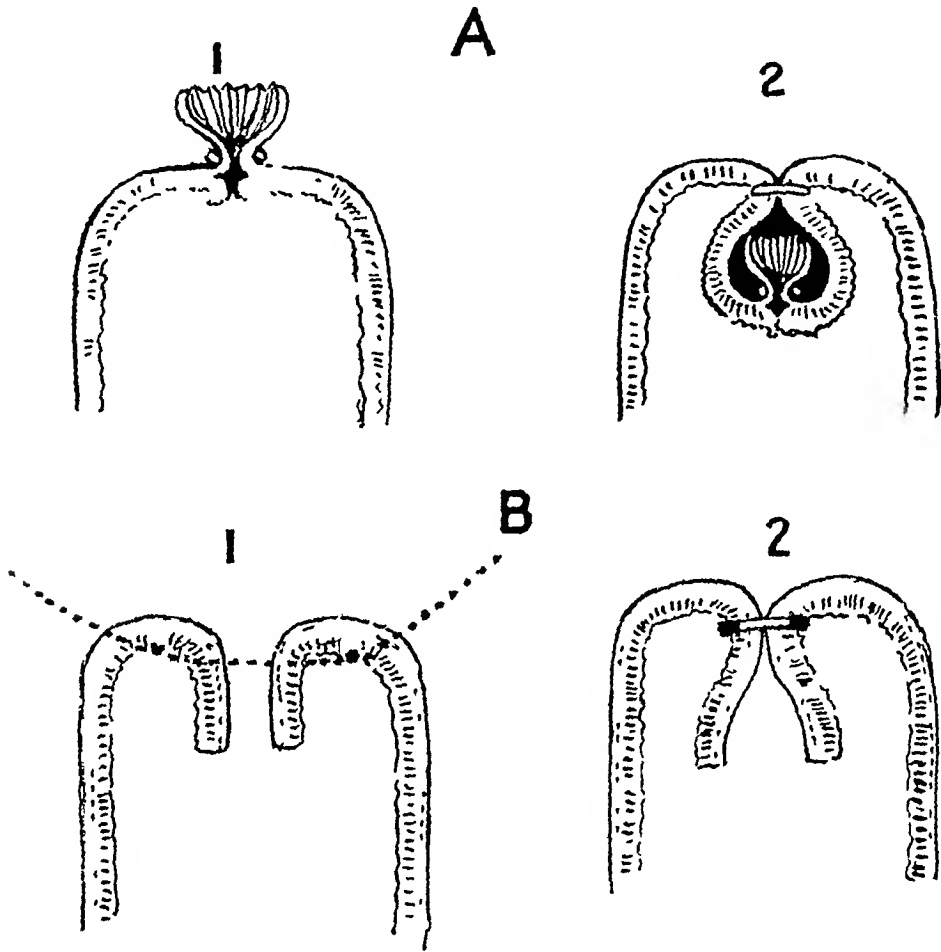


FIG 30 —Schematic cross section showing irrationality of tying the stump of the appendix prior to its inversion. A-1 shows the stump tied, A-2 shows the same stump inverted, with a suture applied over it, note closed cavity formed in A 2 which will be filled with septic material that might burst in the abdominal cavity, note also that when the stump is tied there is no real inversion of the stump but the stump is merely buried between two layers of serosa, inversion can only take place if the stump is inverted without being previously tied as shown in B. B shows inversion of stump without tying it, note inversion and close approximation of inverted serosas which will immediately adhere and close base of appendix, note also that thread enters the lumen B 1 and 2 and is buried in the inverted serosa when inversion has taken place B, 2

is followed, even when it would be impossible to do so, when the usual technic is adopted, because the assistant holds up the cæcum by four threads which prevents the escape of any fluid and undesired premature tightening of the purse-string suture before inversion has taken place, as happens when there are only two ends to the purse-string suture, as in the usual technic, also the purse-string suture applied, as we have recommended does not tear the gut

We never tie the appendix, because we have found that the manner

of inversion we have described gives the best result *quoad vitam* and *quoad functionem*, indeed, by looking at Fig 30A any one will be convinced that when the appendix is tied and then inverted a closed cavity will be formed that will positively be infected, even if the stump of the appendix has been cauterized, or supposedly disinfected with carbolic acid, iodine, or any other chemical, this closed cavity will increase in size by the secretion of the tissues that are closed in, and set up a reaction of the surrounding tissues, which means formation of adhesions in the favorable cases, or rupture and consequent general peritoneal infection or formation of fecal fistula in the less fortunate cases. If a ligature is put around the

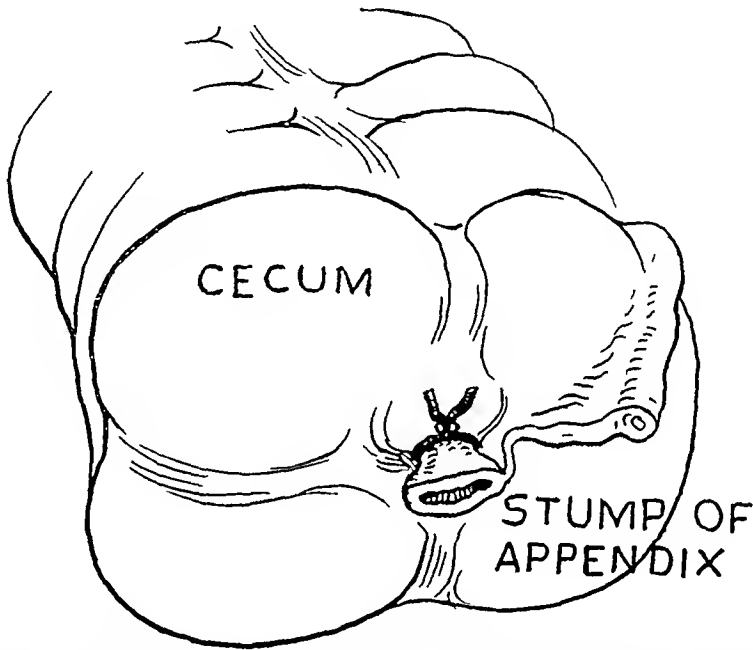


FIG. 31.—Shows stump of appendix simply tied. Note mucosa in direct contact with peritoneum and how easily an inflamed and brittle appendix can be cut by the thread. Note also that stump beyond ligature must be absorbed and therefore will be the cause and centre of adhesions.

appendix without inversion another dangerous condition may arise, the thread is very likely to cut through when applied on very inflamed and brittle appendices, so giving rise to possible general peritonitis or fecal fistula, the base of the appendix must slough off, because being tied (Fig 31) it is deprived of its blood supply, its mucosa is external, all this means that it will set up some infection and later it has to be absorbed by connective tissue of new formation, which means presence of more or less scar tissue later, which means adhesions which might be more or less troublesome, but the formation of which should be prevented in all cases in order to conform to good surgical principles.

The comfort of the patient is of great importance, and we adopt as an external dressing an elastic abdominal belt without any bones (Fig 32), so that the whole abdomen is kept gently constricted, without however,

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undue pressure The elastic belt makes not only the most comfortable dressing, because it holds comfortably the abdominal organs, but it is also the most convenient, because it helps in preventing post-operative hernia and can be released and replaced without inconvenience to the

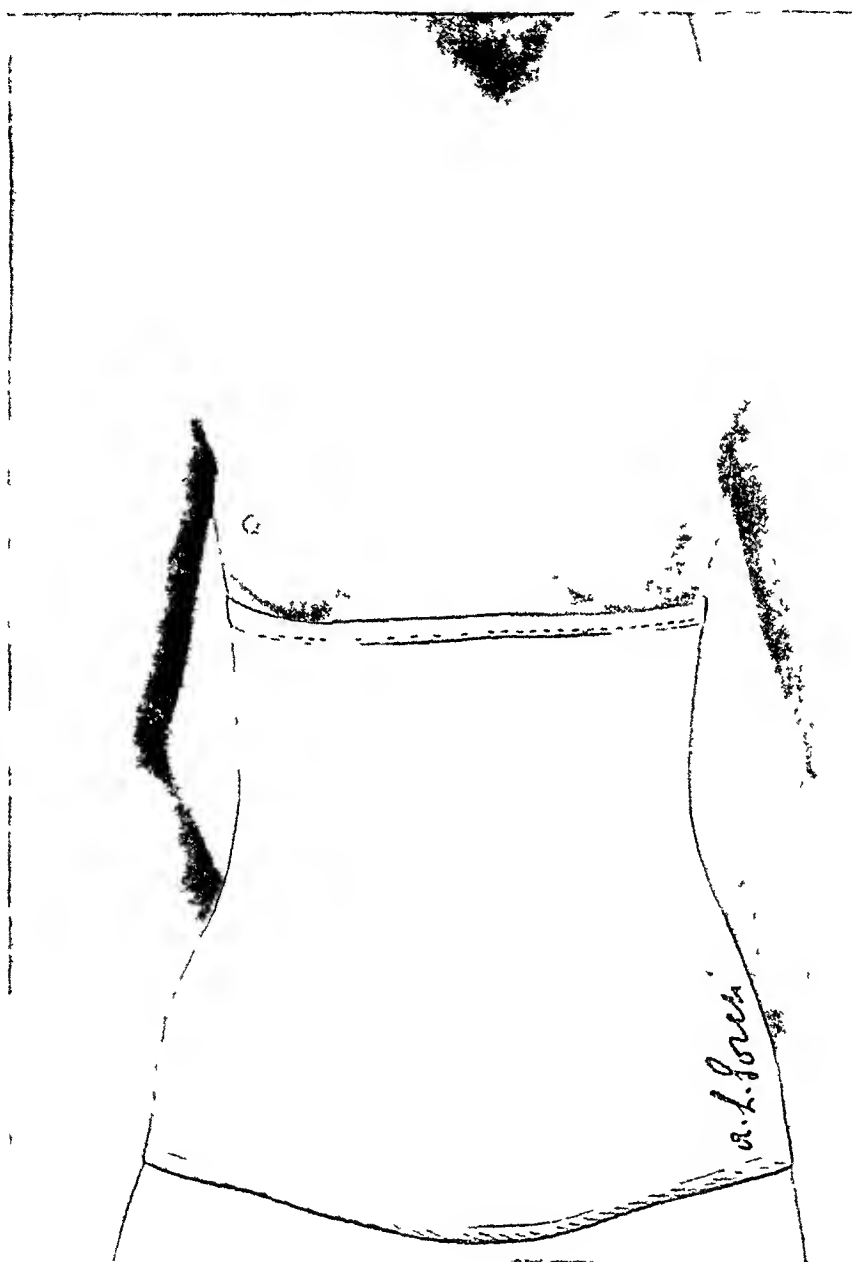


FIG 32 —Showing how elastic abdominal belt without bones is applied as external dressing

patient In order to prevent the necessity of using pads and irritation to the peritoneal organs by the iodine commonly used to prepare the skin, we prepare the skin by cleansing it with ether and then cover it with a solution of rubber and ether, that does not come off and will make the use of pads unnecessary as described in another paper¹

¹A L Sores: Preparation of the Skin for Operation with Solution of Rubber and Ether Instead of Tincture of Iodine ANNALS OF SURGERY January, 1920, p 109

Conclusions —In cases of acute appendicitis the patient's life might be in grave danger whether he is operated or not, the surgeon, therefore, must deal with the case so that he follows the principle of *primum non nocere*, then he has to think that his work must be done in such a manner that the operation will give the best results *quoad vitam* and *quoad functionem*. We believe that the special points of the technic that we advise in all acute cases, ether-rubber preparation of the skin, pararectus incision, freeing of only the external portion of the cæcum, raising up the cæcum so as to expose the base of the appendix, immediately severing the appendix close to its base and inverting it, then following the distal portion of the appendix and removing as much of it as possible, paraffine gravity drainage when pus is present, closure of the abdominal wound in all cases, paraffine gravity drainage of the abdominal wall, elastic closure of the skin, the application of an elastic belt as an external dressing, answer all the desiderata. Indeed, life is saved more often if this technic is followed and we have had striking proofs of this fact in several almost desperate cases, which are not referred to for brevity's sake, than if this technic is not followed, because no one can be sure of the position and condition of the appendix in all cases, and the technic recommended is ideal for all cases, because it prevents the spreading of infection in all cases and does not lower the resistance of the peritoneal organs, and does positively drain out safely any secretions that should be drained out. *Quoad functionem* it prevents the formation of fecal fistulæ, of dangerous post-operative adhesions of post-operative hernia, it allows a maximum of comfort to the patient.

FRACTURES OF THE PELVIS*

WITH A REPORT OF TWENTY-FIVE CASES

By WILLIAM JOHN RYAN, M D
OF PHILADELPHIA, PA

FRACTURE of the pelvis, until very recently, had not received the consideration that is due such a serious injury. It is a much more common result of violence than is generally supposed. Therefore, it is with these thoughts in mind that this series of cases is presented.

The first extensive report based on the findings in the literature was by Quain¹ in July, 1916. He reviewed one hundred and twenty-six cases and reported one of his own. His reported mortality previous to 1890 was 86.7 per cent, since then it was 48 per cent, and since 1905 it is 38 per cent. Since then single cases have been reported by Hawkes,² Moorhead,³ Ross,⁴ Klotz,⁵ Angiovene,¹¹ and Dunott.¹² And Gazzotti⁶ reports two cases with a description and photographs of an apparatus for their treatment. Mitchell⁷ in 1917 read a very exhaustive article on the diagnosis and treatment of fracture of the pelvis. While the author's paper was in the stage of preparation, Mengel⁸ presented his very excellent paper embodying sixty-nine cases before the Pennsylvania State Medical Society last September. These papers totalled 202 cases, and to this number we are privileged to add 21 cases. They were treated in the surgical wards of the University, Polyclinic, and St. Agnes Hospitals on the services of Doctors Frazier, Brinkmann, and Muller, to whom I am indebted for the privilege of reporting them.

Humphrey⁹ describes the ring of the pelvis as heart-shaped, and calls attention to the wide arch with a flattened centre of the upper or posterior half, and the greater curve with flattening at the ilio-pectineal regions of the lower or anterior half. It results from this configuration that the pelvic ring is weakest at five points, *viz*, at or a little external to sacro-iliac synchondroses, at the symphysis pubis, and midway between the symphysis and the acetabula.

In studying the clinical effects of fracture of the pelvis it is helpful to consider it with reference to its various functions.

As interposed between the vertebral column and the lower extremity as a weight bearer.

As a means of providing for motion of the trunk on the lower limbs, and of affording some points of attachment for the muscles governing that motion.

As a bony protection for the abdominal and pelvic viscera. When viewed as a bony ring between the spinal column and the femora, the pelvis is made up of two main arches, one in use when standing and one

* Read before the Philadelphia Academy of Surgery, December 1, 1919.

when sitting The sacrum is the point of union or keystone of both these arches One extends from the acetabulum through the thick bony ilium, through the upper third of the ilio-pectineal line to the sacrum and is called the sacro-femoral arch The other extends from the tuberosity of the ischium through the posterior edge of the acetabulum to the same point and is called the ischiosacral arch These are the essential weight-carrying portions of the pelvis

Morris¹⁰ calls attention to the mechanics of the remaining portions of the pelvis in this way When much strength is essential in an arch it is often prolonged in a ring to form a counter arch, *i e*, the ends of the arch are tied together so as to prevent them from starting outward Therefore, a portion of any weight carried by an arch is distributed to the centre of the counter arch Now in the pelvis the body and horizontal ramus of the pubis form the counter arch of the sacro-femoral arch, and the union of the ramus of the pubes and ischium the tie of the ischiosacral The ties of both arches are united in front at the symphysis which like the sacrum is common to both arches Therefore, it can be easily understood why any severe direct violence applied to the pelvis will result in fracture of the horizontal or descending ramus of the pubis, the ramus of the ischium, and of the ilia external to the sacro-iliac joint

In this series of 21 cases there were seven deaths, a mortality of 33.3 per cent

The youngest patient was six and the oldest sixty-five All had been subject to severe injury

Twelve cases were simple fractures, that is, without visceral complication, though three of them were complicated by fractures of other bones In five cases there was a rupture of the bladder and in three a rupture of the urethra One case which died on the operating table had a torn deep epigastric artery in addition to an intra- and extraperitoneal rupture of the bladder Bloody urine was present in one case without evidence of rupture of the bladder or kidney, due possibly to a contusion of the bladder or kidney An inguinal abscess developed in one case and an abscess over the right hip and gluteal region in another, both several days after the injury In one case there was a penetrating fracture of the acetabulum (mention) This would seem to differ from Doctor Estes' statement in discussing Mengel's paper that "When the body of the pubis and ramus of the pubis are broken by direct violence, drainage is almost imperative It is not simply the rupture of the bladder or urethra, that, of course, makes drainage an absolute necessity But there is in my experience a very large amount of blood effused in the cellular tissues of the perineum and ischio-rectal region, and this blood is nearly always contaminated by colon bacillus or by some slight leakage from the urethra Almost inevitably there is infection" Fracture of the pubis occurred twelve times in this series and in only one of these did such an infection occur—a gluteal abscess (Case XII) The ilium was involved seven

- times, the body of right ischium once The anterior superior spine once, the acetabulum once, and both tuber ischii once The patients that died all had other severe injuries

CASE III—Aged sixty-five Rupture of urethra, multiple fractures of the ribs developed nephritis Died on twenty-sixth day

CASE IV—Died in thirty hours Had a fractured skull, sixth, seventh, eighth ribs, femur, and compound fracture both bones leg

CASE VIII—Ruptured bladder and urethra, signs of internal hemorrhage, profound shock Died in two hours

CASE X—Fractured skull and evidence of a ruptured bladder Unconscious on admission Died in three hours

CASE XV—Ruptured bladder Developed cystitis and general sepsis after operation Died in six days

CASE XVII—Extensive lacerated wounds of the perineum extending up into the abdominal cavity, through the neck of the bladder Died three hours after admission

CASE XVIII—Rupture of bladder, intra- and extraperitoneal Peritonitis present, torn deep epigastric artery Died three hours after operation

Symptoms and Diagnosis—Every case of severe injury in the pelvic region should be looked on with suspicion The clinical findings should be checked up by X-ray, of course, but there should be no delay in operating if it is indicated

The most common symptom is pain, felt usually at or near the seat of fracture It is sometimes described by some patients as "a pain through the pelvis" This pain is increased by pressure inward exerted simultaneously on both hips I agree with Mengel that crepitus should not be looked for because of the danger of injuring the urethra or bladder if they have not already suffered Crepitus was noted on our records three times

Movement of the body causes pain in or near the seat of fracture I feel that rectal examination should not be made in suspected fracture of the ischium for fear of a sharp edge of bone puncturing the bowel

The patient should always be catheterized If bloody urine is withdrawn a given amount of some sterile solution such as boric acid should be injected after the bladder is emptied by catheter and then drawn off again If the full amount is recovered one can feel reasonably sure that the bladder is not ruptured In case the catheter cannot pass because of rupture of the urethra, a perineal section should be done and an attempt made to reconstruct the urethra Drainage should also be provided for It may be necessary to do a suprapubic for retrograde catheterization

Should the bladder be ruptured extraperitoneally there will in addition be a swelling and bogginess over the lower abdomen This, of course, will require incision and proper drainage of the space of Retzius

If the fragments are exposed at the time of operation and can be

replaced in proper position without difficulty, it should be done. Otherwise they had best be let alone.

As to treatment of the fracture. If it is a fracture of the ilium with or without sacro-iliac joint involvement, a plaster cast should be applied around the pelvis, cut out in the proper place to allow for attention to bowels and urine.

If the pubis or ischium is involved a wide adhesive swathe should be applied giving access to necessary wound dressings. In either case the patient should be placed on a Bradford frame with the head end resting on the head of the bed and the foot end on the mattress against the foot of the bed. This will permit attention being given him without disturbing his position.

Of the cases that recovered eleven were traced at the end of a year or more.

Seven were in absolutely normal condition.

One had normal function but had occasional pains in the region of the sacrum.

One had a limp due to shortening in a fractured limb which fracture was sustained at the same time as the pelvic injury.

Another who had a possible rupture of the urethra had some delay in starting urination and some dribbling. Examination disclosed an enlarged prostate. He improved under treatment but drifted from observation.

One case had vague pains through the pelvis though examination was negative.

ABSTRACTS FROM CASE RECORDS

CASE I—Jas. H., aged twenty-three years, admitted January 23, 1918. Was caught under a falling wagon, which struck him on the right hip and pinned him beneath it. He was unable to walk and complained of pain in both gluteal regions. There was some tenderness over the region of the bladder and pressing both hips together caused pain above the symphysis pubis. Temperature was 99, pulse, 82, and respiration, 22. He was catheterized without difficulty, first few c.c. were bloody, but the remainder was clear. Bladder was emptied and eight ounces of sterile boric acid solution injected. Full amount was withdrawn, showing no rupture of the bladder. An adhesive swathe was applied to the pelvis and the patient placed on a Bradford. A little blood continued to leak from the urethra, so a permanent catheter was inserted and the bladder irrigated daily with saturated solution of boric acid. This man was a persistent kicker and did not like or appreciate anything that was done for him. February 13 a plaster cast was applied and kept on until his discharge February 25, one year after injury. He had no symptoms, walked without a limp, and voided freely and without pain.

CASE II—J. P., admitted October 30, 1914. Discharged December 15, 1914. He was knocked down and run over by an automobile. On admission his temperature was normal. Pulse 100, and respira-

tion 26 He complained of great pain in right hip Right leg was rotated externally and abducted Soon after admission he voided clear urine There was considerable ecchymosis about the right inguinal region Otherwise physical examination was negative X-ray showed a linear fracture of the right ilium extending into the acetabulum, and epiphysial separation of the right ischium A plaster cast was applied to the pelvis and extension to the right leg with sand-bags on either side He was then placed on a Bradford frame Five days after this his temperature began to rise and inspection disclosed a large abscess in the right inguinal region This was incised and drained December 10 the cast was removed and on the 15th he was discharged At this time there was some limitation of motion in the right hip The inguinal wound was healed

One year later there was no deformity, he walked without a limp, and manipulations showed no limitation of motion in the right hip

CASE III —J B, aged sixty-five years, admitted November 25, 1917 Died December 21, 1917 Was in an automobile which was run into by a street car Pain and loss of power in the left leg, and pain in the left hip Examination showed an abrasion of scalp Fracture of third and fourth ribs on left side at the costochondral junction Left ilium was freely movable, and crepitation could be elicited over the symphysis Temperature was 97°, pulse, 68, and respiration, 20 A diagnosis of fracture of the pelvis with rupture of the bladder was made X-ray showed a fracture of the descending ramus of the left pubis with considerable separation and a fracture through the body of the left ilium

November 25 Operation by Doctor Muller Under spinal anæsthesia abdomen opened, but no intraperitoneal rupture of the bladder was found The preperitoneal tissues were very much infiltrated with blood Investigation in the space of Retzius showed the bone to be bare and a fracture of the descending ramus of the left pubis with about 1 to 2 inches separation of the fragments A large amount of blood was evacuated and it was thought that the urethra was ruptured near the neck of the bladder Rubber-tube drainage was inserted and the wound closed, with the intention later to do a perineal repair, perhaps accompanied by a suprapubic incision The man was in bad shape all through the operation, caffeine and strychnine were given hypodermically and saline intravenously Before closing the peritoneum 20 drops of adrenalin were introduced following the directions of Porter for the treatment of shock He did fairly well following this operation, but continued to drain urine from the abdominal wound On December 13 an unsuccessful attempt was made to introduce a tube in the bladder with a purse string, so a urethral catheter was connected with the drainage tube in the hope that permanent drainage would be obtained

Urine examination showed amber, 1030, heavy cloud of albumin, no sugar Many light and dark granular casts

This man did very badly after the second operation, gradually sinking into a state of coma from which he never recovered

CASE IV—Mrs H, aged forty-seven years, admitted February 22, 1917, died February 23, 1917. She was knocked down and dragged by a street car. On admission she was in a very desperate condition. She had fractures of the right ilium, and sixth, seventh, and eighth ribs on the right side, depressed fracture of the skull in the right frontal region, fracture upper third of the right femur, compound comminuted fracture both bones of right leg in lower third, and contusions of the entire body. She never recovered from her shock and died about thirty hours after admission.

CASE V—J P, admitted January 7, discharged January 22. Crushed between a crane and some heavy object. Chief complaint was pain in the region of the right hip. General condition was good. Redness and swelling over right hip, tenderness on pressure over the horizontal ramus of the right pubis. Movements of both hips painless, with finger in the rectum, pressure against the right descending ramus elicited tenderness. No blood in the urine or fæces. X-ray showed an impacted fracture of the horizontal and descending rami of the right pubis. There was no pain when lying perfectly quiet. A wide adhesive swathe was applied and the patient placed on a Bradford frame. He was discharged with his adhesive swathe in place and a belt prescribed. One year after he had no symptoms and walked without a limp.

CASE VI—B T, aged thirty-nine years, admitted March 25, discharged April 22. Fell from the platform of a moving train and crashed into a fence. Admitted one hour after the accident.

Pain in region of left hip. Examination showed fracture nasal bone, abrasion and contusion of chest, tenderness in region of left anterior superior spine. Catheterized specimen showed no blood. X-ray showed a fracture of the left anterior superior spine and a split fracture of the left ilium vertically downward two and one-half inches from the crest of the ilium.

A plaster case was applied to the pelvis and he was placed on a Bradford frame. Case was removed three and one-half weeks later and he was discharged in four weeks. At this time he had no pain or tenderness over seats of fracture, but he had some difficulty in completely extending the thigh on the trunk (left). One and a half years later he was without any apparent deformity or functional abnormality.

CASE VII—M P, aged thirty-one years, admitted November 30, discharged December 10. This case was most interesting because it disclosed a deformity due to a failure to diagnose the condition at the time of the accident.

C C. Inability to walk without a support and shortening and weakness of the left leg.

He was a miner, and one year before, while lying on his side, a mass of slate fell and struck him on the left hip. He was treated in the local hospital for ten weeks for a fracture of the left femur. Had on a fracture box and extension. After his discharge he was unable to walk without a support. Three months ago he was again put to bed with extension but with no improvement. When he was

FRACTURES OF THE PELVIS

discharged after his first time in the hospital he complained of a numbness and coldness in the left foot. This has persisted up to the present time.

Examination disclosed a slight flexion and external rotation of the left thigh. Shortening of an inch and a half. When the leg is fully extended there is marked lordosis. There appears to be some ankylosis of the hip-joint. There is considerable atrophy of the entire left leg and thigh. Both knee jerks exaggerated. Area of greatly diminished sensation over the outer side of dorsum of left foot. And all the toes show distinct sensory impairment. Urine shows specific gravity 1026, no albumin, many hyaline, and light and dark granular casts. Neurological condition thought by the neurologist to be due to some injury of the spinal cord at the time of the accident. X-ray shows a penetrating fracture of the acetabular ring with the head of the femur jammed through.

CASE VIII—E S, aged twenty-nine years, admitted June 29, and died the same day. The steering wheel of a truck broke and it plunged through a bridge railing to railroad tracks 75 feet below, carrying the patient with it. On admission he was in a state of shock, but was conscious. There was some tenderness in the right hypochondrium and in the right costovertebral angle. Much swelling in the left inguinal region, and greatly abnormal mobility and crepitus in both ilia. In attempting to catheterize resistance was felt after passing into the perineum, and a few drops of blood flowed out. He died before operation was performed. A diagnosis of ruptured viscus with internal hemorrhage was made.

CASE IX—A S, aged thirty-eight years, admitted April 8, discharged April 22. C C. Pain over sacral region and weakness of the right leg. March 24 he was thrown from a train to the roadbed and struck a rail in a sitting posture. He was taken to a hospital where he remained several days. Was admitted here through the surgical dispensary. He had no symptoms except those mentioned above. X-ray showed a fracture of the descending ramus of the right pubis without displacement. An adhesive swathe was applied to his pelvis and he was placed on a Bradford frame. At the end of two weeks he had no pain and his right leg was apparently normal.

One year later he had perfectly normal function in both legs, but complained of more or less pain over the sacrum in damp weather.

CASE X—J A, admitted November 1, and died the same day. He was admitted in an unconscious condition with a history of having been swept from the top of a train by a bridge. He had a large hæmatoma in the occipital region, was bleeding from the nose and ears and urethra. All reflexes were absent. There was some mobility over the right symphysis and a sense of boggyiness just above the symphysis. He died three hours after admission. A diagnosis of fracture of the right pubis with extraperitoneal rupture of the bladder was made, also a fracture of skull.

CASE XI—J A, aged thirty-eight, admitted October 12, discharged April 2. Fell 35 feet when a scaffold on which he was working

collapsed Examination shows a punctured wound of the left heel, crepitus in left heel and considerable tenderness over lumbosacral region There was no blood in urine Chief complaint pain in back and in perineum X-ray showed a fracture of the horizontal ramus of the left pubis and fracture of the left os calcis and left astragalus He was incontinent of urine and a permanent catheter was inserted An adhesive swathe was placed about his pelvis The incontinence of urine persisted and he also lost control of his anal sphincter His temperature began to rise and a yellow discharge from his penis caused considerable discomfort October 29 a suprapubic cystotomy was done and considerable pus evacuated from his bladder After this he felt better and his temperature dropped to normal

November 17 Was still unable to void, so the suprapubic drain was allowed to remain in Began irrigations of the bladder with boric acid, washing out considerable gravel and pus He regained control of his anal sphincter

January 1 The urine was clear and he was allowed out of bed, he walked fairly well The suprapubic opening was still draining February 10 Lost control of his anal sphincter again Became very much discouraged

February 23 Examination showed the urethra to contain many false passages, one of which communicated with the scrotum

At this time he insisted on going home Refused any further treatment whatever

Unfortunately, this man had moved and we were unable to trace him to his new address

CASE XII —E P, aged sixteen years, student, admitted February 26, discharged April 26 She was struck by a railroad train and was unconscious for two hours There were no signs of a fracture of the skull She could not sit up because of excessive pain within the pelvis There was a compound fracture of both bones of the right leg in the lower third A large bruise on the right hip Measuring from right anterior superior spine to right interior mandibles was 3 to 4 inches shorter than the left side The bases of Bryant's triangles were equal on both sides There was no pain on moving the hips, but there was considerable pain on pressing both hips toward the midline There was a fracture of the ninth, tenth, and eleventh ribs on right side Tenderness over the left ulna about two inches below the olecranon Urine was voided clear

X-ray showed a subperiosteal fracture of the left ulna in upper third Compound comminuted fracture of both bones right leg lower third Fracture of horizontal ramus of both pubes with slight displacement

The opening on the leg at seat of fracture was closed by suture and healed kindly

March 6 Tibia was plated

March 12 Temperature rose to 105°, and examination showed tenderness and fluctuation over right trochanter Investigation with needle showed pus, streptococcus pyogenes

Exploratory laparotomy under N O anæsthesia and eucaine
 Right rectus incision Abdomen negative Appendix removed
 Incision in right hip between trochanter and crest of ilium, large
 collection of reddish fluid evacuated which had dissected its way
 upward and downward It was not purulent in appearance and
 was probably a large retroperitoneal hæmatoma which got out by
 way of the lymphatics

March 27 A large abscess developed in right gluteal region It
 was incised and drained

April she was discharged with all wounds healing by granula-
 tion There was a cast on her right leg There was $\frac{5}{8}$ inch short-
 ening in the right leg because of little callus formation at seat of
 fracture All movements in region of right hip were normal

Two years from the date of her discharge she was able, with the
 aid of an extra thick heel, to walk with almost no limp

CASE XIII—J H, aged fifty-four, admitted July 14, discharged
 August 21 He had fallen from a scaffold and landed on his right
 hip He had no cough or dyspnœa, nor did he complain of any pain
 in his chest Chief complaint was pain in right hip and right groin
 Could not void urine Physical examination of his chest and abdo-
 men was negative He was perfectly conscious There was quite
 an extensive bruise on right hip and his scrotum was swollen and
 ecchymotic Catheterizing him, 200 c c of urine were withdrawn,
 which was very bloody

A permanent catheter was placed in his bladder with a little
 difficulty and an adhesive swathe about his pelvis He was placed on
 a Bradford frame Ten days later the catheter was removed from
 his bladder and he was able to void thereafter without trouble

He was discharged with no abnormal symptoms

Two years after his discharge he could walk without any diffi-
 culty But he complained of dribbling of urine for a short while
 after voiding His prostate was considerably enlarged Light mas-
 sage and hot sitz-bath improved this condition, but he disappeared
 from observation before gaining any more headway

CASE XIV—M K, aged forty-three, admitted January 11, dis-
 charged March 19 Chief complaint pain in left hip and in left side
 of abdomen He was squeezed between two motor trucks which
 collided He was conscious on admission, temperature, pulse, and
 respiration were normal There was a severe contusion and abrasion
 over the crest of the left ilium He voided clear urine and 8 ounces
 of boric acid solution injected into bladder was entirely recovered
 X-ray showed a linear fracture of the left ilium extending from one
 inch behind the anterior superior spine downward to within one inch
 of the acetabulum

A plaster cast was applied to his pelvis and he was placed on a
 Bradford frame

When discharged he was able to walk without a limp and com-
 plained of no pain in the region of the fracture

He returned to his former occupation of laborer and was able to do as much as before his injury

One year later he was without pain and had no deformity

CASE XV—W S, aged forty-five years, admitted August 15, died August 21 Chief complaint severe pain through the pelvis In state of shock He was knocked down by an automobile which ran over his lower abdomen

He was tender over the lower abdomen, there was a sense of bogginess just above the symphysis, severe contusion of the back in the lumbar region, blood was dripping from his penis He was catheterized and only one-half ounce of urine was obtained Eight ounces of boric acid solution was injected into his bladder and only half of it returned Therefore, a diagnosis of ruptured bladder was made

He was given an intravenous infusion of saline and under ether a suprapubic incision was made There was no intraperitoneal rupture of the bladder found, so the space of Retzius was investigated There was found a collection of blood and urine and the fragments of a fractured right descending ramus were found A couple of small loose pieces were removed and a rubber tube inserted for drainage A suprapubic drain was placed in the bladder and a permanent catheter was placed in the urethra He did very poorly after the operation, ran a continuously high temperature and was very flighty Urine showed a heavy cloud of albumin and many granular casts Two days after operation he began to drain pus from the opening in the space of Retzius He died on the sixth day after admission from general sepsis

CASE XVI—Mrs E F, aged forty-one years, admitted September 14, discharged October 22 She was knocked down and rolled beneath a street car She complained of great pain in both hips Her temperature was 97°, pulse, 68, and respiration, 18 She had general contusions all over her body and was so sensitive that examination was very difficult Pressure on both hips caused considerable pain in symphysis region, and she was very tender over both tuber ischii Eight ounces of boric acid injected into bladder was fully recovered

X-ray showed a fracture of the descending ramus of the right pubis and a fracture of both tuber ischii

A plaster cast was applied September 20 and removed October 20 She was discharged October 22, walking normally, but complained of more or less pain on sitting down

Two years after she was in good health and had no symptoms resulting from her accident

CASE XVII—A sailor on *U S S Missouri*, age about twenty-five, was admitted 5 45 P M in state of profound shock, and died at 8 15 P M He had been dragged by a street car The perineum was the seat of extensive lacerated wounds, there were abrasions of both knees and an abrasion involving the entire front of the left thigh and the inner side of the left leg All wounds were bleeding pro-

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fusely, both ilia were freely movable and there was marked depression on both horizontal rami

The wounds were packed with sterile gauze and he was given 600 c c of normal salt solution intravenously with 30 minims of adrenalin. He never rallied from his shock. Died about three hours after admission.

CASE XVIII —G F, aged thirty-seven years, admitted January 11, and died same day about eight hours later. Temperature on admission was 96°, pulse, 80, and respiration, 32. Injured in collision of two motor trucks. Abdomen was very rigid and his urine was bloody, only a few c c being obtained by catheter. Of 8 ounces of boric acid solution injected into the bladder only 2 ounces were recovered.

There was a depression over the horizontal ramus of the right pubis. He was given an intravenous injection of salt solution and taken to the operating room. A suprapubic incision was made, the abdominal wall was greatly infiltrated with blood from torn deep epigastric artery on right side. There was an intra- and an extra-peritoneal rupture of the bladder. Peritonitis was present. The peritoneal cavity, the bladder, and the space of Retzius were drained with rubber tubing and the abdomen closed with through-and-through suture of silkwoim gut. He never fully recovered from his anæsthetic, but died about three hours after operation.

CASE XIX —T McF, aged twenty-one, admitted April 19, discharged May 24. He was caught between a falling timber and the side of a freight car. On admission he complained of severe pain in the right side and the right iliac crest. His general condition was good, no evidence of a rupture of the bladder or urethra was found. A diagnosis of fracture of the right ilium was made and confirmed by X-ray. The fracture beginning 2 inches behind the anterior superior spine running down toward the acetabulum for about 3 inches.

An adhesive swathe was applied and he was placed on a Bradford frame. He made an uneventful recovery and was discharged walking normally and without any pain.

CASE XX —F F, aged thirty-six, admitted May 23, discharged July 10. He had been run down by a light motor car which passed over his lower abdomen.

He was in good general condition. There were abrasions of both hips and a swelling over the symphysis. He complained of some pain in right groin, especially when the hips were pressed together. He voided bloody urine. Eight ounces of boric acid solution was injected into the bladder and only 5 ounces was recovered.

A diagnosis of fracture of the right pubis with ruptured bladder was made and he was operated on immediately.

There was found a rupture of the bladder in the space of Retzius. This space was filled with clots and urine came from the wound in the bladder. The bladder wound was sutured and a rubber tube drain placed in the space of Retzius. He made an uneventful recovery.

X-ray later disclosed a fracture of the descending ramus of the

right pubis We were unable to locate this man at the end of a year and a half

CASE XXI—F T, aged fifty-four, admitted February 14, discharged March 25 He was struck on the side by a piece of falling timber There was a large abrasion over the right hip, pressure on the right crest elicited exquisite tenderness His general condition was very good, X-ray showed a fracture of the right ilium extending from the anterior superior spine downward and backward for a distance of 3 inches

An adhesive swathe was placed around his pelvis He was discharged in normal condition

One year later he was without pain except in damp weather He had no limitation of motion nor interference with locomotion

CASE XXII—T T, a colored girl Knocked down and dragged by a trolley car

On admission she was in fairly good condition There was a contusion of the left leg and hip, fracture of the left humerus She was very tender over both ischii and over the symphysis

X-ray showed a fracture of the left humerus, fracture of the left ischium, and fracture of the horizontal and descending ramus of the left pubis

She was placed on a Bradford frame and an adhesive swathe placed about her pelvis There were no complications and she made an excellent recovery On discharge she was able to walk without support but with a slight limp, favoring the left leg

CASE XXIII—T L, white, a teamster Admitted August 25, discharged October 10

Received in accident ward slightly under the influence of alcohol Gave a history of having been thrown from a wagon He maintained that the wagon passed over his pelvis On examination he was very apprehensive and very nervous There were no signs of any grave injury There were no evidences of a fracture of the pelvis or lower extremity He voided urine freely and it contained no blood He was admitted to the ward and put to bed

The next day he complained that he had considerable pain in his left groin on walking

X-ray disclosed a fracture of the horizontal ramus of the left pubis without displacement

An adhesive swathe was applied and he was placed on a Bradford frame

CASE XXIV—W L, aged forty-five, admitted January 30, discharged March 25 On admission temperature, 97.3°, pulse, 68, respiration, 20 While helping to move a heavy iron tub the hoisting chains broke and it fell, striking him in the back

Abdomen was slightly distended and rigid, but not tender Extremely tender over the left great trochanter and over the symphysis There was a fracture of the middle of the shaft of the left femur with 1¾ inches of shortening

FRACTURES OF THE PELVIS

He was put to bed with extension on the fractured leg and anti-shock measures instituted

Next day X-ray showed a fracture of the left acetabular ring, a fracture of the horizontal ramus of the left pubis, and a fracture of the middle of the shaft of the left femur

No urinary symptoms arose

February 15. There was no shortening

He was discharged walking on crutches

CASE XXV—H B, aged twelve years, admitted May 12, discharged May 22. Knocked down by an automobile which ran over his right hip. On admission he was somewhat shocked. Temperature, 97°, pulse, 76, respiration, 20

Could not stand and complained of great pain in the right iliac crest. Right thigh could be moved freely but with considerable pain. There were no urinary symptoms

X-ray showed a linear fracture of the ilium extending from the crest downward toward the acetabulum. The lower half of the line of fracture split in two

NOTE—Between the time this paper was read and its being sent to the publisher, Cases XXII, XXIII, XXIV, and XXV were discovered in the records. This will bring the mortality down to 28 per cent, and add the following to the bones that were the seat of fracture: Ilium, 1, acetabulum, 1, left pubis, 3, left ischium, 1

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USE OF FREE SKIN GRAFTS TO REPLACE LOSS OF MUCOUS MEMBRANE OF MOUTH AND NOSE *

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FREE skin grafting, particularly in the replacement of the mucous membrane of the mouth, received during the late war an impetus which has carried it out of the class of operations which usually fail, and what may even be termed the experimental stage, and established it as a definite procedure from which an almost positive assurance of success can be given.

Before proceeding to describe a new method, it is always advisable to review the methods that have been used, past and present.

1 Free Ollier-Thiersch grafts have formerly been tried in the mouth, but have usually failed.

2 Mucous membrane flaps from other parts of the mouth. This is the method of choice, when there is sufficient membrane to spare, and there is no danger of producing contracture or shortening of the mucous membrane at the place from which the flap is taken.

3 The taking of a flap from the skin surface to replace oral mucous membrane is a difficult procedure, causing a large amount of scar tissue, and only too frequently the flap will be hair bearing, which is a very disagreeable complication. However, it has a decided place in closing a large defect or in making an entire lip.

4 *The Free Ollier-Thiersch Graft, Held in Place Under Pressure*—To Esser (*ANNALS OF SURGERY*, Philadelphia, 1917, lxx, 297) belongs the credit for introducing the buried free skin graft. In seeking a means for applying Thiersch grafts evenly and maintaining them immovable under equal pressure on the wound for several days, Esser conceived the idea of stretching the skin graft on an impression of the wound made in dental modelling composition, inserting this in the hollow of the wound, and suturing the edges of the wound over it. It is interesting to note the evolution of the present operation from this. To correct certain deformities or contractures in which there was a loss of mucous membrane, Esser incised the skin over the contracture, and dissected down to the contracture but not into the mouth. Of this cavity he made an impression in modelling compound. Upon the impression he placed a Thiersch skin graft, with its raw surface out, and then introduced it into the cavity and sutured the skin edges over the compound. Ten days later he incised the scar tissue from within the mouth, and removed the compound, leaving the graft in place, lining the cavity which was then con-

* Read before the Philadelphia Academy of Surgery, December 1, 1919.



FIG 1

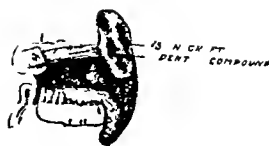


FIG 3



FIG 6

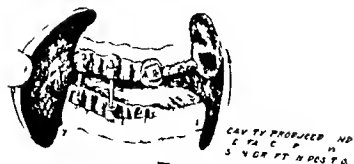


FIG 2



FIG 4

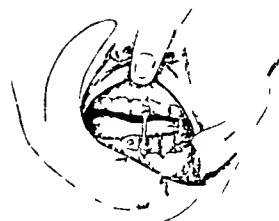


FIG 7

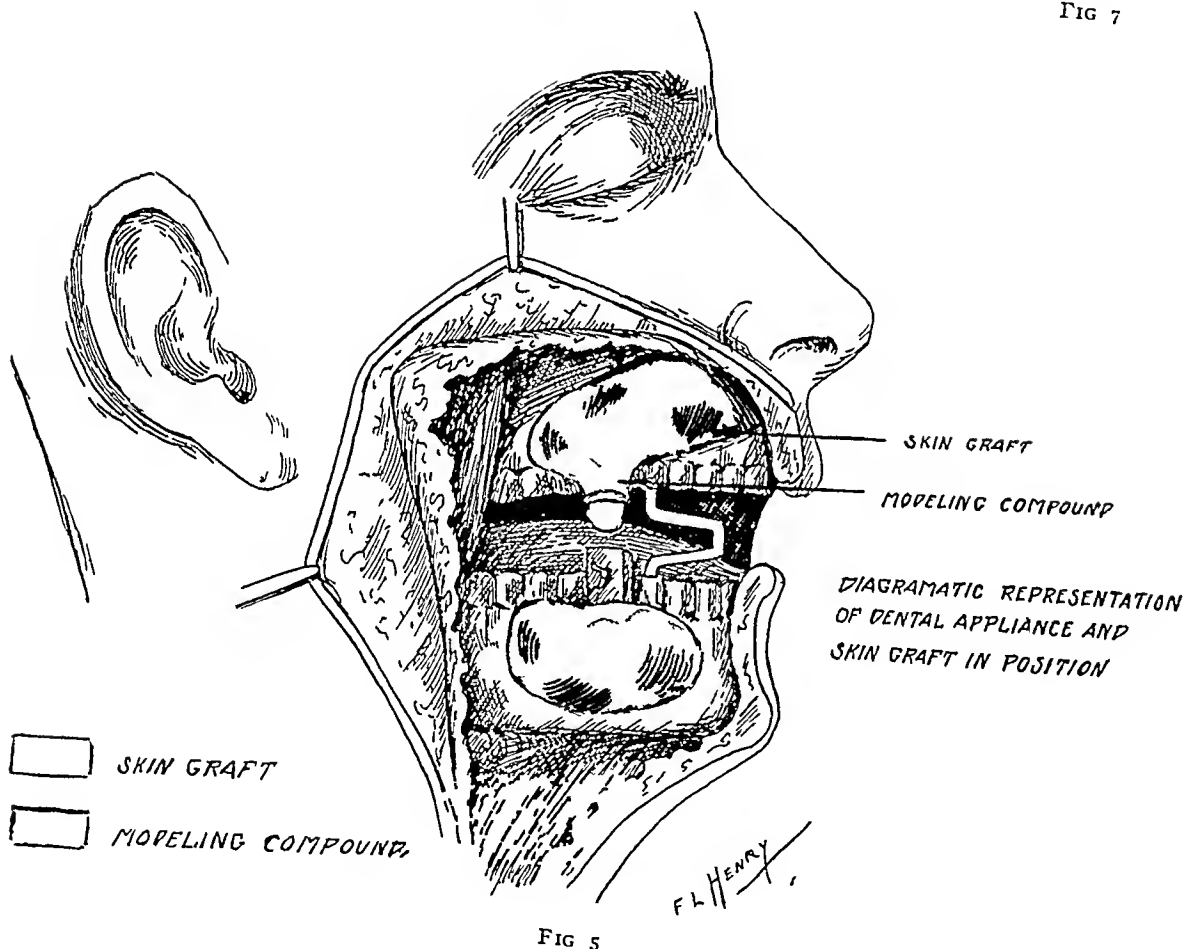


FIG 5

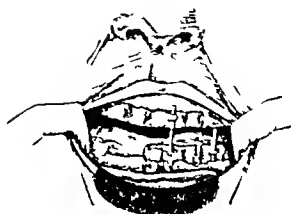


FIG 8



FIG 9



FIG 10



FIG 12



FIG 11

tinuous with the mouth cavity. Now why did the graft take? Let us try to give the reasons why grafts on the skin surface often fail: (1) An accumulation of serum under the graft. (2) Formation of crusts around the grafts. (3) The grafts are not kept warm and at uniform temperature. (4) They are frequently moved or pulled off in changing the dressing or when the dressings are moved by muscular action. The success of the modelling compound support depends upon the correction of all these defects. In general skin grafting, we have found a greater number of takes could be obtained by covering the grafts with an accurately fitting layer of modelling compound. This is brought about by taking an accurate impression of the area and one inch of the surrounding skin in modelling compound, before applying the grafts. Then the grafts are applied and covered by the modelling compound. This method was first seen by me at the Queen's Hospital, Sidcup, England, on Major Gillies' service. The modelling compound employed in this work is the ordinary impression material used by the dentists, which is readily softened in hot water.

Major Waldron, R A M C (Canadian Forces), at the Queen's Hospital, Sidcup, modified Esser's procedure by dividing the scar tissue through the mouth instead of externally, making a cavity into which he introduced an accurate impression of modelling compound covered with a Thiersch graft. He then sutured the incision in the mucous membrane. The compound usually remained in place for several days, then came out or was removed, the graft, however, remaining as a lining for the cavity. The objection to this plan was that there was too much movement. The compound could not be kept in place as long as desired to prevent subsequent contracture. The staff of the Queen's Hospital, Colonel Newlands, Major Gillies, Major Waldron, and Major Pickerill, modified and improved Waldron's method by attaching the compound to a splint fastened to the teeth. In this manner the graft covering the compound was held firmly pressed in place. An impression of the cavity produced by dividing the scar tissue was taken in compound which was then attached to the splint, the compound being covered with a Thiersch graft and pressed down firmly in place. The compound was allowed to remain for ten days, and at the time of its removal, to avoid secondary contracture, was replaced with a vulcanite piece, worn for several weeks. Lt Col G C Schaeffer, M C, U S A, holds the modelling compound in place by passing sutures through the cheek or the floor of the mouth and tying them over gauze on the skin surface. This is a simple method, but should be used only where it is impossible to obtain a dental appliance.

In the Maxillo-Facial Service at U S Army General Hospital No 11 at Cape May, I used the method employed at the Queen's Hospital, but found several minor changes desirable:

1 We dissected out the scar tissue, enlarged the cavity much beyond what was desired, then put the jaws in an open-bite splint (Figs. 1 to 5).

I find others do not use this splint as much as we did. Its advantages are that it keeps the mouth in one position and in an over-corrected one, so that the final result will not be interfered with by subsequent contraction. I strongly advise the open-bite position for these cases.

2 We retained the original compound in place for fourteen to twenty-one days and always followed its removal by the insertion of a vulcanite model for several weeks. The graft should not be sutured over the compound as it defeats the object desired, that is, the compound is only supposed to hold the graft against the raw surface. The point to be remembered is that the compound should be held in place under pressure. If any of the graft extends over normal mucous membrane, it does not do any harm.

In lining a skin flap with Thiersch graft as in Figs 7 and 8, the

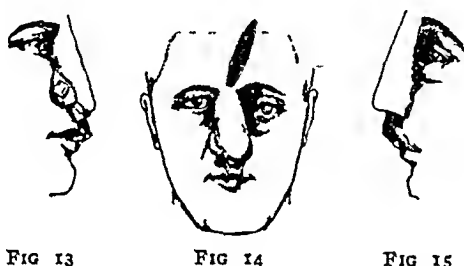


FIG 13

FIG 14

FIG 15

appliance is put in place, the flaps are made, and then the compound is covered with the graft, finally, the flaps are sutured over the compound, in contact with the graft. The lining of skin flaps in this manner was entirely satisfactory, but where possible a full thickness skin flap is preferable. One would frequently see the patient vomit over the grafts immediately after the operation. No harm resulted.

The Thiersch grafts in the mouth were pale in color, but several months later changed and became much the same as normal mucous membrane. In lining the nose with epithelium, which is an essential in rebuilding a nose, it is frequently impossible to obtain sufficient skin to make a flap for this purpose. To overcome the difficulty, we had an attachment connected to an appliance on the teeth bearing a mould of wax or modelling compound over which the outer skin flap would fit accurately (Figs 10 to 15). On the inner surface of the skin flap was applied a Thiersch graft. So long as the flap accurately covered the mould, just so long did one get the grafts to take. A Thiersch graft will take in any part of the nose if held accurately in place.

OPERATIVE TREATMENT OF UNUNITED FRACTURES OF THE MANDIBLE

By ROBERT H IVY, M D , D D S

OF PHILADELPHIA, PA

THIS report is based upon observation of twenty-two patients with non-union following gunshot fracture of the mandible, in the writer's service at the Walter Reed General Hospital. These cases came to operation after the lapse of periods ranging from six to seventeen months



FIG 1 —Cases VI VII VIII and XXII Type of splint suitable for cases with sound teeth in each fragment Band around molar tooth in posterior fragment connected to segment of splint on anterior fragment by adjustable screw-bar

following the original injury. In all cases a thorough trial had been given to conservative methods of treatment. In twenty-one there was free mobility between the fragments, in one a rather firm fibrous union in very bad position had occurred complicated by large loss of substance. The non-union in these cases was primarily not due to lack of early fixa-

* Read before the Philadelphia Academy of Surgery, December 1, 1919

tion, but was principally caused by the large loss of bone substance and inability on the part of nature to bridge the gap resulting when the collapsed fragments were drawn apart and fixed in proper position. The loss of bone was due not so much to primary destruction as to extensive shattering followed by infection and necrosis. If the fragments had not received early attention in the form of reduction and fixation, we should have had a much larger number of cases of union in bad position, requir-

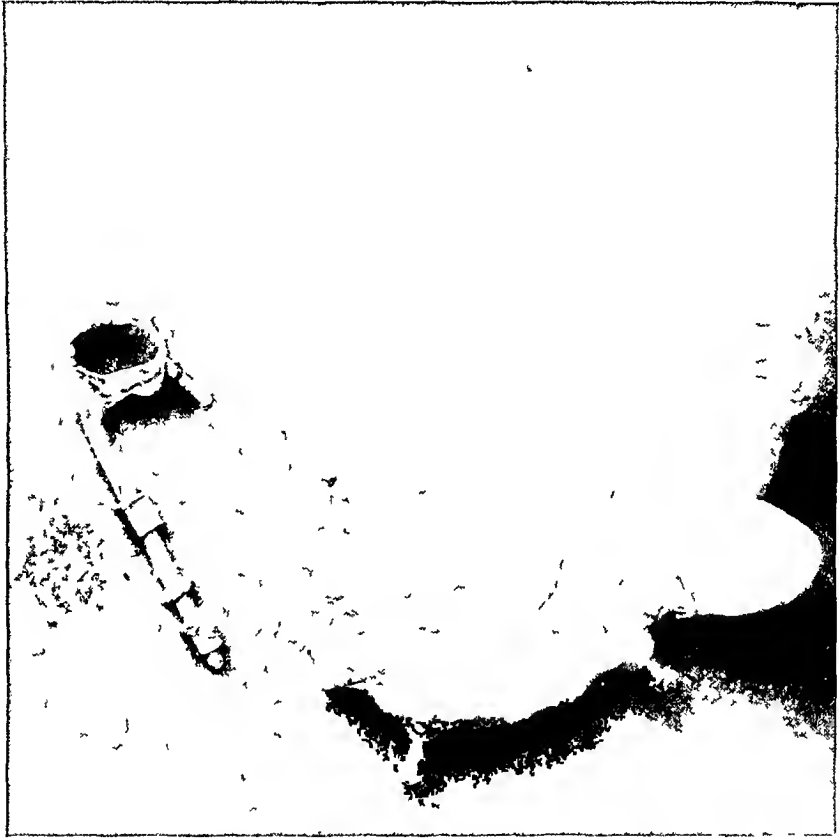


FIG 2 —Same splint unassembled showing flange on side opposite fracture to keep mandible from swinging over to affected side during mastication. Flange plays against upper molar teeth.

ing two separate operations of surgical reduction and bone grafting, instead of grafting alone. At the present time exact figures are not available giving the percentage of cases of non-union in gunshot fractures of the mandible seen in the recent war, but the writer would roughly estimate it at ten per cent.

Of the twenty-two cases operated upon, eleven involved the body, three the symphysis, two the symphysis and body, three the angle, one the angle and ramus, and two the ramus.

The object of treatment in these cases is primarily restoration of the function of mastication. This is attained by restoring the normal occlu-

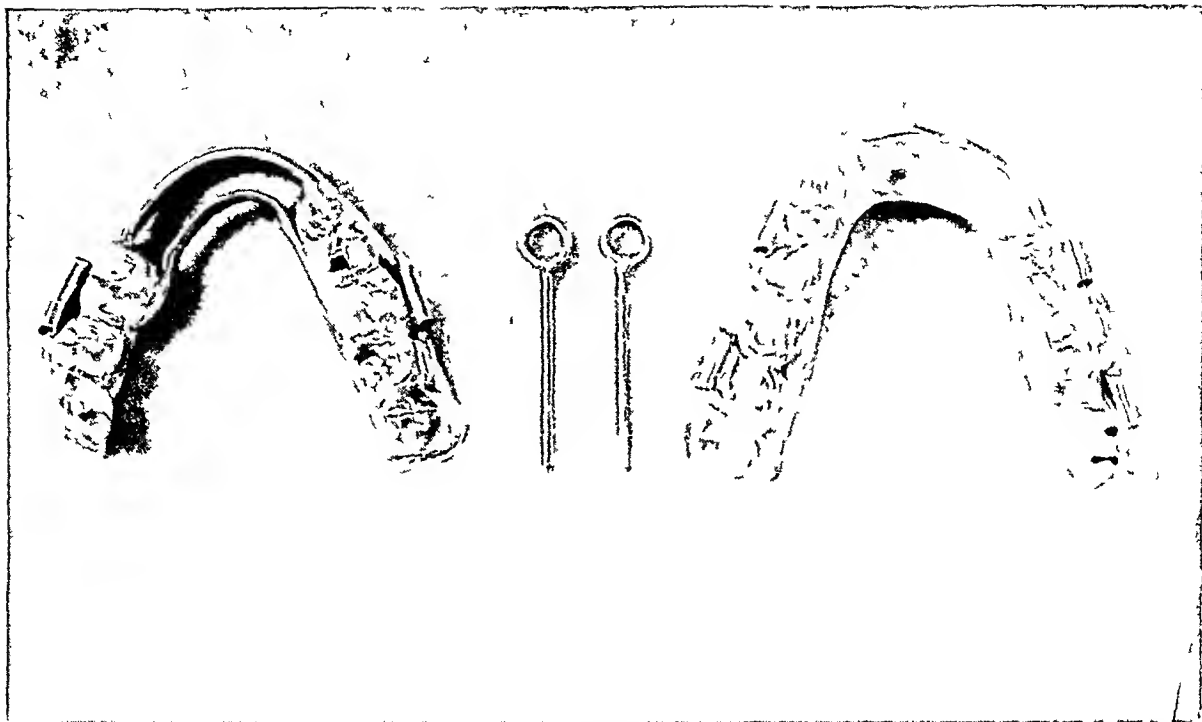


FIG 3 —Case XIII Upper and lower cast metal splints with removable lock-pins to permit opening of mouth if desired



FIG 4 —Cases IV, XIV XVII XVIII and XIX Vulcanite saddle for ramus attached by extensible threaded rod to splint on upper teeth Sound side of mandible held over in place by splint attached to upper by lock-pins

sion of the teeth and filling in the lost continuity of the bone. One is of little value without the other.

The *preoperative* treatment of these cases was that applied to all fractures where union without operation is expected, namely, removal of all septic foci, reduction, and fixation in such position that the normal occlusion of the teeth is restored.

Septic foci include roots of teeth projecting into the seat of the frac-



FIG 5—Same splint unassembled

ture, other teeth showing evidence of periapical and periodontal disease, bony sequestra, metallic foreign bodies, and infection in the soft tissues overlying the seat of fracture. No operation should be attempted to restore the continuity of the bone until all sources of infection have been removed and until at least six weeks have elapsed after all sinuses and septic wounds have healed.

Reduction is brought about in cases of non-union by manipulation and the immediate insertion of a previously made splint which fits on the teeth and maintains the normal occlusal relationship between the upper and lower teeth. Occasionally, where there are many sound teeth it is

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possible to fix the fragments by means of wire ligatures attaching the lower teeth to the upper. The interdental splints are cast in silver after accurate impressions and plaster casts of the teeth of the individual cases have been prepared. In some cases the splints are made in segments, one for each mandibular fragment, connected by an adjustable screw-bar whereby reduction can be gradually brought about. Where there are sound teeth in each fragment, it is frequently only necessary to splint



FIG 6 —Case XIII Loss of 2.5 cm. at symphysis before operation

the mandible (Figs 1 and 2). This has the great advantage of permitting mastication and also allows enough motion to promote bone growth. In other cases, and always where there are no teeth in the posterior fragment, as in the case of fracture at the angle, it is necessary to splint the upper teeth as well as the lower and lock the two splints in occlusion by means of removable bolts on each side (Fig 3). The upward and forward tilting of the ramus of the mandible by the action of the masseter and internal pterygoid muscles is gradually corrected by means of a vulcanite saddle covering the soft tissues of the ramus, backward and downward propulsion being obtained by a threaded rod connecting the

saddle to the upper splint (Figs 4 and 5) It has been found advisable to remove the saddle after reduction has been accomplished and before performing the bone graft operation, because it causes some irritation to the soft tissues and may lead to infection of the graft Acknowledgment is due to my associates Major Joseph D Eby and Captain Roy L Bodine, of the Dental Corps, for their most efficient and necessary co-operation in handling the problems of reduction and fixation in these cases

In cases of firm fibrous or bony mal-union, operative reduction must



FIG 7 —Case XIII After pedicled graft Did not unite on one side and required reinforcement by osteoperiosteal graft

be resorted to The skin is divided, the seat of fracture exposed, and the line of union cut through to permit complete separation of the fragments to their normal position, which is maintained by the application of previously prepared dental splints If the mucosa of the mouth has not been opened by this procedure, a graft may be at once inserted If the mouth cavity has been made to communicate with the external wound, the bone graft operation must be postponed until complete healing has taken place This applies also to accidental opening of the mucous membrane of the mouth in preparing a bed for a bone graft The graft will not live in the presence of infection from the oral secretions I was unfor-

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tunate enough to have this accident occur in two cases of the present series, necessitating immediate discontinuance of the operation and postponement of the bone grafting for several weeks

Operative Procedures—Anæsthesia In all cases ether anæsthesia was used. It was given intrapharyngeally through nasal tubes. The bottle containing the ether was attached to an oxygen tank, the bubbles of oxygen carrying the ether to the patient, there being thus no necessity for a foot bellows or motor pump. It was never found necessary to use the



FIG 8—Case XV Loss of 1 cm. in right body of mandible before operation

intratracheal method. The technic employed permitted continuous administration of the anæsthetic and at the same time complete isolation of the field of operation by sterile towels which covered the entire head and face, except the seat of fracture.

Types of Graft—Three different methods of restoration of the lost bone substance have been used in the present series, as follows

- (1) Pedicled bone graft from the mandible itself
- (2) Osteoperiosteal graft from the tibia
- (3) Graft from the crest of the ilium

(1) *Pedicled Graft*—The method followed is that described by Cole

(*British Journal of Surgery*, July, 1918), in which a piece of the lower border of the anterior fragment is removed by means of an electrically driven saw, with a pedicle of digastric muscle and fascia left attached to it below for nourishment. This is carried back to fill the gap and fastened to the ends of the fragments by means of silver wire.

(2) *Osteoperiosteal method of Delangeniere* (*Bull et Mem Soc Chir Paris*, May, 1916). This consists in first exposing the ends of the fragments and preparing a pocket around each by stripping back the peri-



FIG 9—Case XV. Shortly after pedicled graft operation.

osteum and soft tissue for a distance of about 1 cm. The graft is made by the removal of a thin shaving of bone from the antero-internal surface of the tibia with a chisel, leaving the overlying periosteum attached to the graft. One piece of this is inserted in the pockets beneath the ends of the mandibular fragments and another in a similar manner over the fragments, with the bony surfaces of the grafts facing each other. It is necessary that the grafts be in contact with the previously freshened bone ends. No fixation is used beyond suturing the deep tissues over the grafts and ends of the bone, dependence in this respect being placed entirely upon the splints. The osteoperiosteal graft is flexible, easily

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adjustable to the size and shape of the lost bone substance, and contains all the elements necessary for osteogenesis

(3) *Crest of the Ilium*—After first thoroughly exposing the ends of the fragments they are trimmed off and freshened, and a hole is drilled in each through which a silver wire is passed. An incision is now made along the crest of the ilium, beginning at the anterior superior spine, the muscles attached to its inner and outer surfaces are stripped down, and a piece of bone of sufficient length and depth removed to fill the gap in the



FIG. 10.—Case VII. Before sepsis had cleared up, showing drain in place.

mandible. A hole is drilled in each end for passage of the silver wires for connection to the mandible. The detached muscles are brought over the site of removal of the graft, and sutured together with catgut, and the ilium wound closed.

Space will not permit the giving of many of the details of these operations here, but a few points will be mentioned. Whichever of the three methods be used, the grafts must not be touched with the gloved hands, and should be transferred immediately from their original site to their new environment. Careful hæmostasis must be carried out before insertion of the graft and again before the wound is closed. If there be slight

oozing a small rubber drain is left in place for twenty-four to forty-eight hours

The indications for the various types of graft will now be briefly discussed

The *pedicled* graft is satisfactory in cases of loss of substance up to 3 cm in the body or symphysis of the mandible. It is not applicable where the ramus is involved. It has the advantage of furnishing a piece of bone that has not been cut off from its blood supply and which acts



FIG 11—Case VII Shortly after placing osteoperiosteal graft

not as a mere scaffolding for the rebuilding of new bone to fill in that lost by the injury, but which is from the first an integral part of the mandible. The *pedicled* graft is not so vulnerable to infection as the free bone graft, and union will, as a rule, take place more rapidly than where a free graft is used. On the other hand, in the writer's experience the technic of the *pedicled* graft is more difficult, takes longer, and the operation is attended with more hemorrhage than in the case of the free graft.

The *osteoperiosteal* graft is regarded by the writer as being on the whole the most satisfactory for the great majority of cases, and the most universally applicable. It is suitable for loss of substance of any extent,

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and in any position. It can be made to assume almost any desired shape. The technic is the simplest. It perhaps requires longer to obtain complete consolidation than by other methods, and no dependence, of course, can be placed upon the rigidity of the graft itself for fixation.

The *crest of the ilium* furnishes a graft that can be adapted to a small or a comparatively great loss of substance. It is especially suitable in cases where immediate rigidity is desired, *viz*, where too much dependence cannot be placed upon splints for fixation, and also for an immediate



FIG 12 —Case VII Showing bone regeneration two months after operation

cosmetic result where the loss of substance has produced much visible deformity.

Results—In the twenty-two patients the graft operation was repeated in three, making twenty-five operations in all. Of these fourteen were osteoperiosteal, five were pedicled, and six were from the crest of the ilium. Of fourteen osteoperiosteal grafts, eleven, or 78.5 per cent, are completely consolidated or in process of consolidation, in two only partial regeneration took place, and had to be reoperated upon, while one was lost from suppuration. In the two cases in which regeneration failed to occur, the ramus was involved. Regeneration does not take

place as readily nor as rapidly in the ramus as in the body of the mandible

Of five pedicled graft cases, three are cured, while in two regeneration was incomplete and reinforcement by a second, osteoperiosteal operation was necessary

Of the six cases of ilium graft, five are undergoing consolidation,

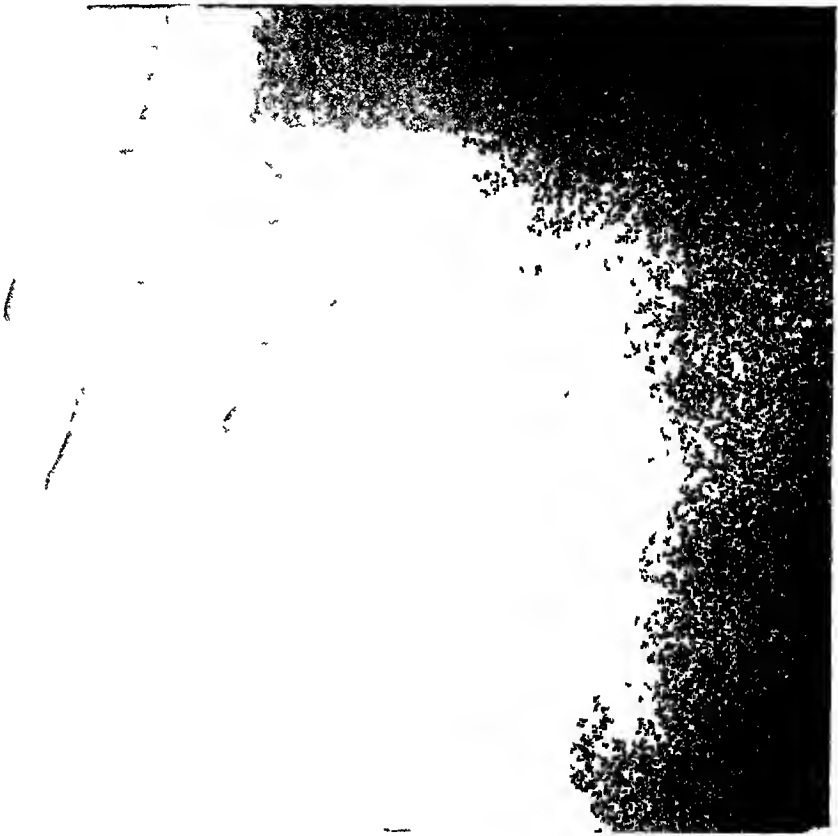


FIG 13 —Case XXI Mal union requiring operative reduction

while one was lost from suppuration, and another operation will be required

Thus, of a total of twenty-five operations, nineteen, or 76 per cent, were successful In four of the failures complete regeneration did not occur, while two supplicated Of the twenty-two cases all but two are either cured or in process of firm solidification These two still remain to be re-operated upon, and it is confidently expected that a good ultimate result will be obtained in them

In both of the cases in which the graft was lost from suppuration the saddle extension splint was used over the soft tissues of the ramus and caused considerable irritation from pressure Therefore, it is now considered wiser to use the saddle only to reduce the displacement of the ramus and to remove it before the operation

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In all cases but one the occlusion of the teeth will be good after removal of the splints and replacement of lost teeth. In one case the splint slipped at one end several days after the operation, and the occlusion will not be perfect.

The splints are kept in place for at least three months after the graft



FIG. 14.—Case XXI. Showing ilium graft in place.

operation, this depending upon the extent and seat of the loss of substance. The teeth are unlocked at intervals to permit gentle exercise and stimulate bone growth. Follow-up radiographic examinations are made once a month.

The appended table gives a summary of the twenty-two cases.

ROBERT H IVY

SUMMARY OF CASES

Case	Date of injury	Seat of injury	Substance lost	Method of fixation	Date of operation	Type of graft	Result
1NC	7/30/18	L angle	2 cm	Intermaxillary wiring of teeth	4/4/19	Osteo-periosteal	Cured
2OK	10/4/18	L angle	3 cm	Cast intermaxillary splints	4/25/19	Osteo-periosteal	Cured
3EH	9/26/18	R body and symphysis	4 cm	Cast intermaxillary splints	6/23/19	Osteo-periosteal	Consolidation taking place
4PG	10/10/18	L body	3 cm	Intermaxillary splint and saddle	7/11/19	Osteo-periosteal	Consolidation taking place
5PD	7/30/18	L angle and ramus	3 5 cm	Cast intermaxillary splints	4/22/19	Osteo-periosteal	Only partial regeneration
6MM	9/29/18	R body	2 5 cm	Cast mandibular splint	5/12/19	Osteo-periosteal	Cured
7FM	10/11/18	R body	3 cm	Cast mandibular splint	5/28/19	Osteo-periosteal	Cured
8JM	7/4/18	R body	2 cm	Cast mandibular splint	7/9/19	Osteo-periosteal	Cured
9WS	9/28/18	L ramus	2 5 cm	Intermaxillary wiring of teeth	7/14/19	Osteo-periosteal	Consolidation taking place
10EO	7/17/18	R body	2 cm	Intermaxillary wiring of teeth	7/30/19	Osteo-periosteal	Consolidation taking place
11HB	7/28/18	R ramus	1 5 cm	Intermaxillary wiring of teeth	(1) 5/7/19 (2) 9/19/19	Osteo-periosteal Pedicled	Only partial regeneration Consolidation taking place Cured
12OH	9/26/18	L body	1 cm	Intermaxillary wiring of teeth	3/26/19	Pedicled	Cured
13RP	5/31/18	Symphysis	2 5 cm	Cast intermaxillary splints	(1) 4/2/19 (2) 7/21/19	Pedicled Osteo-periosteal	Only partial regeneration Cured
14HS	10/15/18	Symphysis and r body	4 cm	Intermaxillary splints and saddle	8/13/19	Pedicled	No union at one end
15CH	10/14/18	R angle	1 cm	Intermaxillary wiring of teeth	8/27/19	Pedicled	Cured
16FS	9/28/18	Symphysis	2 cm	Removable spring clasp splint	8/29/19	Pedicled	Cured
17CD	9/26/18	R body	3 cm	Intermaxillary splints and saddle	(1) 4/18/19 (2) 8/8/19	Osteo-periosteal Ilium	Lost from suppuration Consolidation taking place
18AR	9/26/18	R body	2 5 cm	Intermaxillary splints and saddle	8/25/19	Ilium	Lost from suppuration
19JB	7/15/18	R body	5 cm	Intermaxillary splints and saddle	8/18/19	Ilium	Consolidation taking place
20GC	10/8/18	R body	2 5 cm	Cast mandibular splint	9/5/19	Ilium	Consolidation taking place
21CF	3/4/18	Symphysis	5 cm	Cast intermaxillary splints	8/22/19	Ilium	Consolidation taking place
22AT	7/29/18	R body	2 5 cm	Cast mandibular splint	9/12/19	Ilium	Consolidation taking place

BONE INLAYS AND BONE PLATINGS

BY RICHARD J. BEHAN, M.D.

OF PITTSBURGH, PA.

It has been stated by the advocates of bone plating that bone plating can be done in certain cases where to do an inlay would be impossible.

I shall briefly describe a case where, apparently, this difficulty existed, but, nevertheless, the difficulty could have been overcome if we had exercised ingenuity at the time of operation and had applied a mechanical principle which was very apparent afterward.

The patient had been injured some time previously by a fall of slate which caused an overriding fracture of the lower portion of the humerus. It was impossible to hold the fragments in position by any form of traction apparatus. This was partially the result of the very marked muscular development of the arm.

An open operation was done. A piece of bone was cut from the upper fragment, forced into the medullary cavity, and driven into the medullary cavity of the lower fragment. In doing this a portion of the upper fragment, which had been fractured, came away entirely. Because of this it was impossible to keep the intramedullary splint in place in the upper fragment. A bone band was thrown around but did not seem to act efficiently. Two sutures of kangaroo tendons were then placed around the intramedullary inlay and the lower end of the upper fragment and seemed to hold the fragments in place. The fragment of the bone which had separated entirely was then removed, as it could not be placed back in position.

The arm was now put up in splints in proper position. However, a picture taken some time later showed that there was an inward displacement of the upper end of the lower fragment and that the inlay, which had been inserted into the medullary cavity of the lower fragment, was overriding the upper fragment and lay to the inner side of this fragment.

There was also present a slight musculospiral paralysis.

A second operation was performed December 24, 1919. The arm was exposed, cleansed with iodine, and an incision was made to the outer side of the old scar. There did not seem to be much muscular tissue beneath the scar tissue, the scar being in contact with the bone. Careful dissection was made until the musculospiral nerve was found. It curved around in the groove in the angle between the two fragments. It was surrounded at one point by very dense scar tissue. This scar tissue was separated and the nerve was freed from its bed. Care was taken not to injure the two branches passing out of the triceps muscle. The nerve at the point where the scar was present seemed to be oedematous, rather dark in color, and slightly thickened. Below this point it seemed to be of normal

size and consistency and of normal color. It was drawn to one side by means of a piece of gauze placed beneath it, to protect it from injury during the further manipulation. The two fragments were now separated and the lower fragment was found to still have, in the medullary cavity, the intermedullary bone peg, which had been inserted at the previous operation. The upper fragment of the bone was separated from the lower. The lower end of the upper fragment had a well-marked rounded prominence. An attempt was now made, by drilling a hole up through the lower frag-

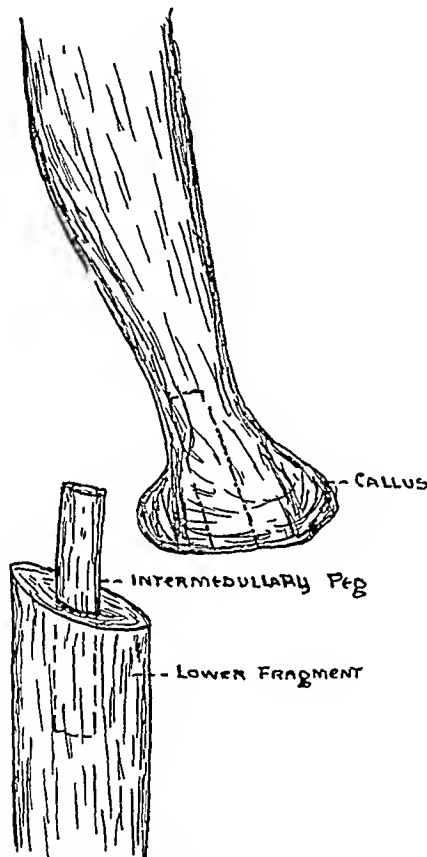


FIG 1—Showing the pathology found at the time of the second operation. The dotted line shows the tunnel in bone into which the bone peg was inserted.

ment, to insert the bone peg (Fig 1). After it was inserted however, the callus gave way and angulation again took place. An attempt was then made to groove the inner surface of the upper fragment and to hold the peg by means of a bone band (Figs 2 and 3). This was also unsuccessful. Then the peg was removed from the lower fragment and the upper fragment was sharpened and forced down into the medullary cavity of the lower fragment, and seemed to hold very well (Fig 5). Holes were drilled through the lower part of the upper fragment and a kangaroo tendon was inserted and tied. This seemed to hold very well, except at this point

BONE INLAYS AND BONE PLATINGS

the intramedullary part of the upper fragment, somehow, through manipulation, became broken. It was now necessary to place a bone plate on the inner surface of the bone (Fig 6). The musculospiral nerve was then drawn to one side. A new path was made for it so

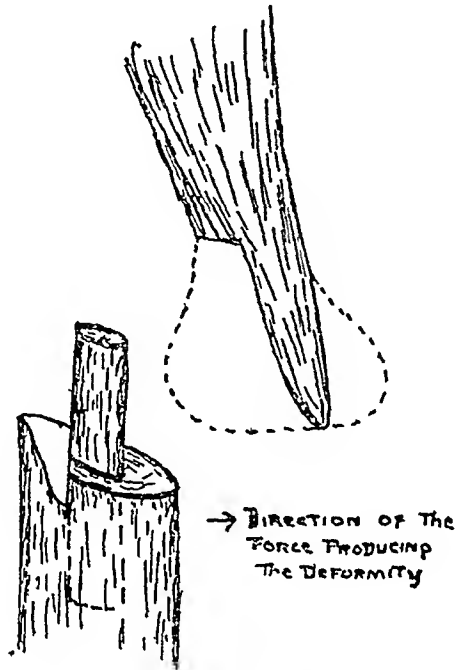


FIG 2 —Second attempt at reduction

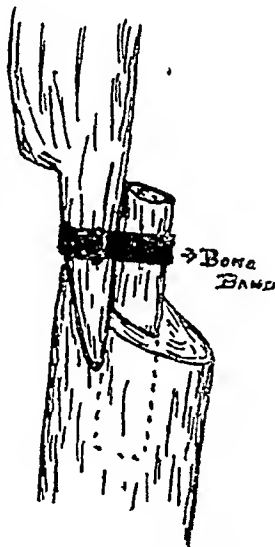


FIG 3 —Third attempt at reduction

that the nerve lay in fatty tissue. The muscle was drawn over the end of the fragment and sutured to the fascia on the opposite side of the incision. The skin and superficial tissues were closed. The arm was placed in right-angular extension.

Fig 4 illustrates perfectly the method that would have held the

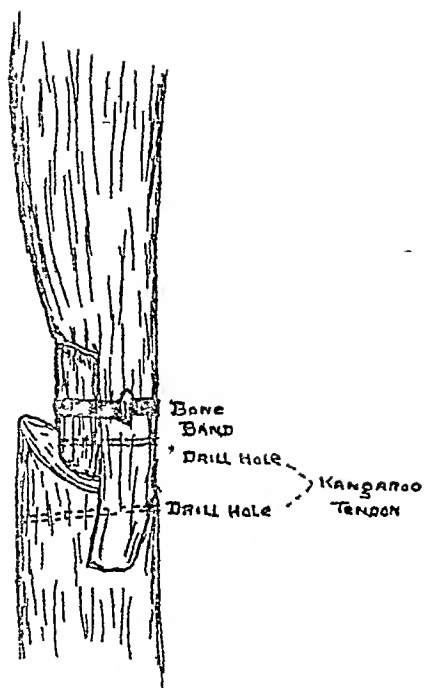


FIG 4—Method which should have been used

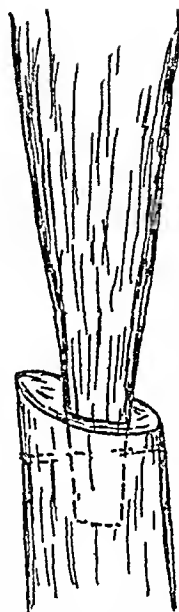


FIG 5—Fourth attempt at reduction Tapering peg made by shaping the upper fragment (Schematic)



FIG 6—Fifth attempt at reduction . Bone band used

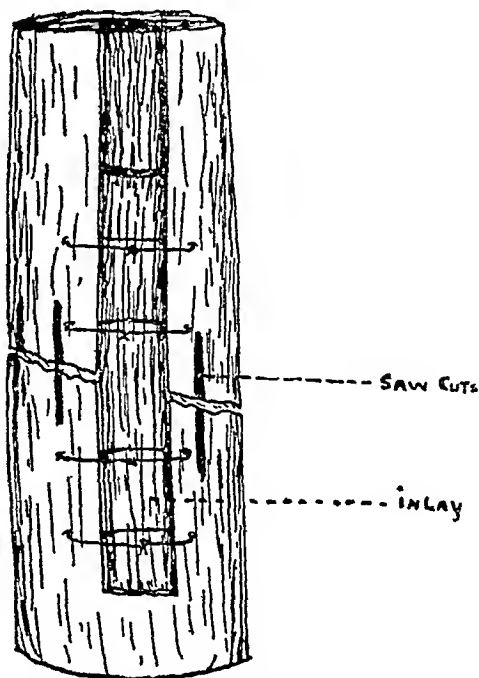


FIG 7—Shows inlay inserted—with the parallel saw cuts

bones in position. Because of their tendency to inward displacement, the wedging-in of the lower portion of the upper fragment between the intramedullary peg and the cortex of the bone of the lower fragment would have held them firmly in position. Then if a bone band had been placed around the fragments in this position and two sutures of kangaroo tendon had been inserted, as indicated, it would have been impossible for the bone to become displaced.

However, this was not thought of until after the operation had been completed. Nevertheless, it is a worthy suggestion that may be attempted successfully at the next operation for this type of fracture.

Because of the inability to hold the fragments in position that the bone plate was applied in this case. However, if we had used the method which I describe and which I suggest above, it would not have been necessary to have used the bone plate. In doing bone inlays I have also found it very advantageous, in order to hasten osteogenesis, to make several slits in the bone, parallel to the longitudinal axis, as illustrated in the accompanying cut (Fig 7).

This is also a very useful method where an intermedullary splint has been used.

A CONSIDERATION OF THE SURGICAL HAZARDS IN DIABETIC PATIENTS

By NELLIS B FOSTER, M D
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CORNELL DIVISION

AN increased risk of operation when the surgical disease is complicated by diabetes is quite generally recognized, but it is not so commonly appreciated that complications which might be regarded as surgical are the immediate cause of death in a large proportion of cases of diabetes. While statistics based upon hospital records are not completely satisfactory, since only certain types of disease are apt to be admitted to hospital, yet, in a general way, data of this sort are significant. A careful review of the clinical records of two good hospitals brought out the following somewhat surprising facts. Of the fatal cases of diabetes dying beyond the third decade of life, about 60 per cent of the fatalities occur following operations. Of the surgical cases with a fatal termination, 70 per cent die in coma. It has been the habit, apparently, to endeavor to make some estimate, in cases such as the above, as to the degree of severity of the diabetic state, and the terms commonly employed are mild, moderate, and severe. The estimations of the severity of the disorder were based evidently upon the glycosuria. Accepting this classification for what it is worth, it is found that coma occurs after operation as often in mild cases of diabetes as in the apparently severe, which, of course, means that the estimations were made upon faulty criteria.

Surgeons are accustomed to classify operations as minor or major, into which classification a number of factors enter, but the meaning of these terms is quite generally understood. Using these terms in the sense commonly accepted we find that the mortality in diabetic patients is higher following minor operations than it is in general for major operations. Of course, one recognizes here at once that major operations might not, as a rule, be attempted on diabetic patients, certainly not without consideration, but this brings more into contrast the erroneous estimation often placed upon the hazard of minor surgical procedures in diabetic patients.

These preliminary considerations bring up the questions which I wish to discuss. Although surgeons and internists alike recognize that an increased hazard attaches to any surgical operation when this operation is done upon a diabetic patient, yet it is not so generally recognized that the factors which go to make up the increased risk can be analyzed and to a very high degree estimated.

From what has already been said it would seem evident that glyco-

suria is not a reliable guide in the estimation of the severity of diabetes, in fact, it is doubtful if it is any guide at all further than a rough diagnosis. Glycosuria does not invariably connote true diabetes mellitus, on the other hand, the absence of glycosuria does not completely exclude this disease. It is generally recognized at the present time that diagnosis and much more the estimation of the severity of the disease depends upon the degree of hyperglycæmia under varying conditions of diet.

It is not inappropriate in this connection to call attention to the type of diabetes which may not show glycosuria. Where the disease has existed for a considerable period of time renal degeneration quite commonly occurs. The earliest clinical manifestation of this complication is very often an increase in blood-pressure. In time it is noticed that the glycosuria gradually abates and, in not a few individuals, completely disappears, so that one is told by the patient that at a certain period in his life he suffered from diabetes for a number of years, but of this was "cured." A thorough examination, and especially blood-sugar estimations, reveals the true condition, which in effect is that the pathological condition in the kidney has progressed to a degree so that even a considerable increase in the blood sugar is not manifested by sugar in the urine. One may accept it, then, as established that diabetes mellitus can be diagnosed and the severity of the disease estimated only by determining the hyperglycæmia.

Relative to our discussion are those factors which influence the normal blood sugar by increasing it, since they produce the same effect to a greater extent in the diabetic state. Chief among these must be mentioned infections. Persons who are not afflicted with any metabolic disease show, when they are the subjects of chronic infections, disturbances in the metabolism of sugar, and this disturbance is characterized by an increase of the blood sugar beyond the normal limit after the ingestion of glucose and a prolongation of the blood-sugar curve beyond the normal two hours. Chronic infections in diabetic subjects induce a similar change, which is expressed clinically in the difficulty experienced in reducing by diet the hyperglycæmia to normal, moreover, this disturbance, produced by infection, implies on the part of the diabetic organism an increased difficulty in the metabolism of glucose and, on that account, the tendency to acidosis is more marked. These fundamental facts are well exemplified in even minor infections in diabetic individuals.

A diabetic patient may have progressed in a most satisfactory manner for a considerable period of time and he may have acquired an ability to utilize an appreciable amount of carbohydrate, the blood sugar remaining during this period practically normal. At this juncture he develops tonsillitis. The blood sugar increases and, even though the patient may take scarcely any food, sugar returns to the urine. A decrease in the metabolism of glucose is manifested by some degree of acidosis, even after the infection has passed. It may require a considerable period of

time before conditions are restored to what they were prior to the inter-current infection. In children relatively mild infections of this sort not infrequently lead to fatal acidosis and coma. The same changes in the metabolism accompany the numerous infections which require surgical treatment, carbuncles, cellulitis. The next factor that is important, in cases where surgical treatment may be required, is the influence of anæsthesia upon the carbohydrate metabolism. Every surgeon knows that glycosuria is occasionally manifested after anæsthesia. Accompanying this disturbance there is more or less acidosis, depending upon the nature of the operation and the period of time of anæsthesia. Here, then, as with infections, we have a factor which aggravates and intensifies the peculiar disorder which characterizes diabetes. The third important factor which comes in for consideration is the predisposition of the diabetic to infections and the diminished recuperative power manifested by his tissues when infections are established.

In resumé of these detailed facts it would seem evident, then, that the severity of diabetes in any given case can be estimated only by blood analyses, that infections tend to increase the severity of the disturbance of carbohydrate metabolism and, in that way, bring about a variable degree of acidosis and that the low resistance of the tissues to infection prolongs and intensifies the carbohydrate disturbance and hence of the acidosis. Anæsthesia, and especially ether, intensify the disordered processes.

A recognition of these facts should make it possible, it would seem, to determine, at least, when operation cannot be borne by a diabetic subject. These facts also suggest that an estimation of the hazards is possible in border-line cases. The chief danger is always acidosis and coma, and, for that reason, a determination of this factor is the prime requisite. Estimations of the CO_2 combining power of the blood give a very definite idea of the degree of acidosis, and this estimation requires only a few minutes. Normal blood shows a combining power for CO_2 above 55 per cent. Severe degrees of acidosis are evidenced by a combined power of 20 per cent or less. No diabetic patient has come to my knowledge who has successfully withstood any operative procedure whose blood showed a combining power of less than 30 per cent. Based upon a considerable experience, it is my present opinion that with CO_2 of the blood plasma less than 35 per cent an operation is too hazardous to attempt. Forty per cent is the lowest figure that permits a reasonable margin of safety for surgical procedures, considering the superimposed acidosis consequent upon the course of infection and the anæsthetic.

Even when the acidosis estimation gives a satisfactory result, the degree of hyperglycæmia cannot with safety be ignored. One sees many diabetics with no acidosis, but with a blood sugar over 35 per cent, who succumb to operations because of the acidosis that develops postoperatively. When the blood sugar is a higher figure than this at the time of operation a fatality is probable. One may say, then, that patients

showing hyperglycæmia of over 35 per cent, or a CO_2 combining power of less than 40 per cent, cannot be expected to survive any operative procedure. The only safety with cases of this type is to change the metabolic state prior to surgical treatment. If there is not time to do this the case is hopeless.

At the other extreme are the cases with no acidosis and with blood sugar only twice normal, who survive operative procedures, even infections requiring surgical treatment, in a fairly high percentage. In all cases demanding surgical treatment, with the exception of emergencies, preoperative care is possible and, with the great majority, even with severe types of diabetes, the acidosis can be abolished and the hyperglycæmia reduced to a safe margin.

The treatment of patients with diabetes mellitus as a preparation for surgical operation requires a departure in no respect from recognized principles. The object of this treatment is the restoration of normal metabolism and the measure of success is the blood sugar and CO_2 of the plasma. There is but one primary means to this end, dietetic, and it is difficult for many to apprehend that in this disease food is a two-edged sword, and its use requires a nice scientific precision. In the first place, because the affections requiring surgical treatment are so frequently infections, and this infection predisposes to acidosis, attention to this factor is never subordinate. Symptoms of acidosis are protein in character and they can be anticipated by laboratory methods, then, too, radical changes in diet often produce a temporary increase of acidosis, which must be watched, and this is especially true in surgical cases. Although hazardous unless controlled by constant laboratory tests, fasting effects, with some cases, the most rapid decrease of hyperglycæmia and acidosis. Unfortunately, when infections of a surgical character complicate the primary diabetes, fasts are not infrequently accompanied by a rapid increase of acidosis. In the latter case there is no recourse except some form of nourishment. The diet at this juncture is determined by two considerations: (a) Fats are direct precursors of the ketone bodies and hence are contraindicated, (b) carbohydrates are being utilized scarcely at all by the body and therefore, if given, elevate the blood sugar and induce acidosis. This leaves only protein for food and this may be used as lean meat and eggs, with small amounts of green vegetables as a relish. The food intake should not exceed 300 calories daily at this period. In some instances a low diet such as described can be interpolated with fast days with benefit.

The use of alkalis in acidosis is general and the effect too often disappointing. When given by mouth it is essential to give large amounts—2 to 3 grammes (30–45 grains) an hour, until the CO_2 of the blood is raised to a safe margin. The soda is best given in Vichy water. Recently I have given soda bicarbonate emulsified in olive oil subcutaneously—

10 to 15 grammes of soda in 10 c c of oil¹ Attention to a copious fluid intake and catharsis is important here, as in uræmia

This brief statement of the principles and methods gives an outline of the treatment which must be adapted to particular exigencies as they occur Some patients with moderately advanced diabetes can, by treatment of this type, be carried through operative procedures, but not all Some, especially those with virulent infections of the cellulitis type, do not respond to any method or procedure

On the other hand, when the complication which requires surgical treatment is not an infection, it may not be excessively difficult to reduce the hazard incident to diabetes very considerably The successful amputation of the breast for carcinoma, complicating moderately severe diabetes, illustrates the point Infections, however, remain the chief problem and the operations should be considered with the care accorded to brain tumors

¹ A suggestion of my colleague, S R Benedict, Professor of Chemistry

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting held December 10, 1919

The President, DR WM A DOWNES, in the Chair

THE ELECTRO-MAGNET RADIATOR-VIBRATOR

DR. W C LUSK presented a series of patients in the treatment of whom the electro-magnet radiator-vibrator of Muller had been used. These included cases of painful wound scars, an amputation stump, a stiff ankle with equinus (supramalleolar fracture), a stiff shoulder (fracture surgical neck of humerus), a stiff elbow (supracondyloid fracture without anterior-posterior displacement and fracture internal condyle), a stiff elbow (abscess arm), and a stiff finger following wound around its base. These cases were to illustrate a paper to be later published.

DR A P WHIPPLE, speaking in regard to the case reported by Doctor Lusk referred by him, said that there was definite ankylosis of the arm following the cellulitis, on admission to the hospital the patient was supposed to have had an arthritis, but two or three punctures failed to withdraw pus from the joint. The cellulitis was very extensive, and the prognosis was considered bad from the standpoint of function because of the long time the cellulitis persisted, and because of the atrophy and stiffness of the muscles. Having seen this patient since her treatment by Doctor Lusk he wished to testify to the remarkable improvement in function and particularly to the loosening up of the stiffness in the dense scar tissue which was present around the elbow-joint as a result of the cellulitis.

DR ROYAL WHITMAN, in reference to the third case of recurring discomfort in the ankle, suggested that the patient had limitation of dorsal flexion of the foot, which if definitely overcome would assure a better final result than would relief of the symptoms by the vibrator.

DR W C LUSK, in closing, replying to Doctor Whitman's suggestion, said that the patient in question had come very irregularly for his treatments, having received only 29 in three and one-half months, since which time, for an interval of over eight months, up to four days ago, he had not been seen. When he reported four days ago, he had considerable limitation of dorsal flexion of the foot, but following one treatment with the magnet on that date, using vibration over the tendons around the ankle and radiation, his dorsal flexion became at once quite a little increased, so the very slight limp which he then had, and had rarely been

seen without since recovering the use of his foot, entirely disappeared, and with another treatment yesterday the degree of dorsal flexion was further added to

EXCISION OF THE BODY OF THE SCAPULA FOR SARCOMA

DR JOHN ERDMANN presented a man of twenty years who was first seen by him some five weeks before, when he gave the history that for one year he had suffered excruciating pain in the right shoulder, was unable to sleep, and had lost weight. On examination there was a large tumor occupying the body of the scapula on the right side. Four weeks ago the scapula was excised, leaving the neck of the scapula, chiselling through the spine and acromion posteriorly and then through the scapula. The tumor involved the two sides of the bone symmetrically. He has gained rapidly in abduction, which Doctor Erdmann believed to be due to the adherent attachments of the stumps of the muscles associated with the head of the humerus. Examination of the growth showed it to be an osteosarcoma. Good healing without sloughing has occurred.

DR ROYAL WHITMAN said that after paralysis of the shoulder muscles from anterior poliomyelitis patients learn to elevate the arm by means of the biceps and coracobrachial muscles. He thought that the abduction in Doctor Erdmann's case might be thus explained.

MIKULICZ OPERATION FOR CARCINOMA OF THE SIGMOID

DR SEWARD ERDMAN presented a man who, at the time of admission to the New York Hospital in October, 1916, was sixty-six years of age. He gave the history that for two years he had had occasional bloody stools, which he thought due to hemorrhoids, with mucus, there had been constipation with tenesmus and spasmodic pain in the rectum. He had been losing weight for a year and there was marked weakness. Four weeks prior to admission he had fainted at stool. On admission he had obstipation, passing only blood and mucus by stool, and suffered a great deal of pain in the lower left abdomen. He was very anæmic, his blood examination showing red blood count, 3,200,000, hæmoglobin, 26 per cent, white blood count, 11,000, polynuclears, 72 per cent, negative Wassermann. On October 23, 1916, he was transferred to the surgical service, where a proctoscopic examination revealed an ulcerating tumor projecting into the rectum with no lateral attachments that could be reached by the finger, it was a nodular tumor evidently invaginated from higher up and reaching to within three inches of the anus. An X-ray was taken, but the barium enema did not reach the descending colon. On October 30, 1916, an exploratory laparotomy was performed, on opening the abdomen a mass 3 inches in diameter and 4 inches long was found in the pelvis invaginated into the rectum. This was reduced by light traction and proved to be a tumor of the sigmoid at a distance of 10 inches from the

anus There were no palpable glands discovered and no evidences of metastasis in the abdomen As there was a long mesosigmoid it was decided to draw out the whole loop through a left iliac incision, and this was done after ligating the mesosigmoid opposite the tumor for a distance of about 5 inches in order to have less bleeding at a later stage Then the whole loop of intestine 8 inches in length was brought out through the intermuscular incision, but not opened at this time Four days later with the cautery the loop of bowel, except for a proximal and a distal stump of about 1 inch each, was removed, gas-oxygen anæsthesia being used Following this procedure he continued to gain in strength and the artificial anus was quite satisfactory Three weeks after the original operation, without using any anæsthetic, a right-angled clamp was applied to the spur between the two loops of bowel, five days later the clamp had cut through and the patient had the first normal passage per rectum Under local anæsthesia on the thirty-seventh day after the first operation the bowel edges were freed and then closed with Lembert sutures, the skin and subcutaneous tissues were closed with three interrupted silkworm-gut sutures, there being no attempt at muscle repair On December 20, 1916, the patient left the hospital with a healed wound, but with a hernia There had been no attempt at repair of this hernia as the patient had done so well

The report on the growth was malignant adenoma of the large intestine, polypoid, representing an early stage of adeno-carcinoma

DR W S SCHLEY presented two cases in which the Mikulicz operation for tumor of the sigmoid was performed Both of these cases were adeno-carcinoma of the sigmoid The first patient was operated last January, having been first seen in the out-patient department and referred to the medical service for examination She complained of slowly increasing constipation Proctoscopic examination disclosed a growth in the lower sigmoid, and she was therefore transferred to the surgical service A median laparotomy was done, and at the same time a colostomy performed on the left side, bringing out a loop of gut, which was immediately opened into proximal side and large tube inserted, held by double purse-string suture to secure immediate evacuation Doctor Schley had never seen any peritoneal soiling from this procedure, the suture usually lasts from three to five days without leakage, and by that time peritoneal adhesion is sound Two weeks later it is his practice to resect the growth, make an anastomosis, establish drainage, and ten days later put a double clamp on the spur created and thus cut a good-sized opening A double clamp is utilized because it gives a more complete and easier anastomosis and makes the closing of the colostomy wound much easier than a single clamp This patient did well until during her convalescence she developed an acute cholelithiasis requiring the performance of a cholecystectomy At the present time both wounds are in very good condition, showing simple linear scars and entirely free from herniation

The report on the tumor was adeno-carcinoma of the circular, or angular, constricting button type. There had been no evidence of metastasis.

The second patient preferred to continue to wear a colostomy apparatus to having his side closed. He was operated *two and a half years ago*, having entered the hospital with an acute obstruction, the result of a gradually increasing constipation. His median scar is very good and there was no bowel protrusion at colostomy. It is hoped that before long he will accede to the suggestion of complete closure. The report upon the tumor was also adeno-carcinoma.

In reference to such cases Doctor Schley laid stress upon the advantage of a *long spur* of bowel over a short one for an easy anastomosis by clamp, upon transfusion prior to operation in cases showing a hæmoglobin below 60 per cent, and in the creation of colostomy by intramuscular incision.

THE MIKULICZ TWO-STAGE OPERATION OF PARTIAL COLOSTOMY

DR CHARLES N DOWD read a paper with the above title, for which see ANNALS OF SURGERY, February, 1920, p 155.

He also presented the patient referred to as Case III in his paper. Since leaving the hospital he had gained thirty pounds in weight and was in excellent health. He had done routine work as a policeman for a part of the time. He had a small hernia which gave him almost no discomfort.

DR JOHN DOUGLAS showed a patient in whom resection of the cæcum and ascending colon was performed in three stages who was an exhibition of the three-stage operation rather than of the Mikulicz operation. She entered St Luke's Hospital in December, 1917, with symptoms of acute obstruction in the region of the hepatic flexure and beginning of transverse colon. She had had an acute attack of pain twenty-four hours previous to admission, the bowels had not moved for forty-eight hours, and she had had symptoms of a general gastro-intestinal type for over ten years. On admission she was acutely ill and in poor general condition, therefore a cecostomy only was done, opening the intestine at the highest possible point proximal to her obstruction, at this time it was possible to see the growth, which was a carcinoma of considerable size, at the hepatic flexure, densely adherent to the duodenum. It did not appear that resection would be possible. Two days later the gut was opened by Doctor Douglas. The patient proving very uncomfortable from the cecostomy with a high colostomy, and having stood the first operation so well, it seemed justifiable to attempt an ileo-colostomy. Therefore, on February 2, 1918, a second operation was performed, making a right rectus incision inside the cecostomy opening, cutting off the ileum close to the ileocaecal valve and making a lateral anastomosis distal to the growth. The patient recovered so well from this second procedure that Doctor Douglas explained to her the advisability of attempting the removal of the growth, to which she acceded, and on March 2, 1918, he

performed the third operation. This proved rather difficult, the growth was extensively adherent to the duodenum and in separating it a portion of the duodenal wall was damaged, but not opening the mucous membrane. The patient, however, recovered from this third operation, showing very little reaction, and three weeks later was discharged with the wound entirely healed. There is now a hernia resulting, however. There has been no sign of recurrence, she has kept up her weight, and at sixty-five years is as well as ever. Report was an adeno-carcinoma of the cæcum.

DR WILLY MEYER believed that the procedure of Mikulicz, which brings the malignant tumor at once outside of the body and at the same time permits of the closure of the peritoneal cavity, was of great advantage. It should be the operation of choice wherever the gut can be brought in front of the abdominal wall. Yet not infrequently it is necessary to proceed in a different manner. He cited three cases operated on in the course of last winter in each of which he had to pursue a different course. The first patient was a female who had a large adherent carcinoma in the ileocæcal region and also suffered from pronounced secondary anæmia. Drainage was necessary, an immediate extensive operation was considered unadvisable. Therefore, a median incision was made and an ileo-colostomy with the transverse colon done. Eighteen days later the ordinary incision over the ileocæcum was made, the tumor removed with the lower end of the ileum and the ascending colon, both ends were then inverted and firmly closed. The patient made a good recovery.

The second case was one where the X-ray was misleading. The patient was admitted with the symptoms of intestinal obstruction, she was a woman of sixty-three years who had intermittent painful peristalsis, but nothing palpable. The barium-clysma showed a free passage up to the ileocæcal valve. On this evidence her family physician asked that she be transferred to the medical service. Showing more symptoms of intestinal obstruction, she finally developed a pronounced tympanites and was returned for surgical treatment, an artificial anus was made in the cæcum. Doctor Meyer believes it a good procedure to stitch the cæcum through a McBurney incision to the abdominal wall and then with the pointed Paquelin cautery open the gut, if possible, in two stages. A large tube is wedged into this opening and stitched to the dressing. In the case referred to there was perfect drainage. Two weeks later a median incision was made, the tumor was resected, both ends were inverted, and lateral anastomosis done. The patient made a good recovery.

In the third case there were no symptoms whatever of intestinal obstruction. On vaginal examination a suspicious tumor was palpated. A left rectus incision showed a cancer in the left parametrium of the lower sigmoid which was adherent to the bladder. After exposure the mesosigmoid was not long enough to allow of its being brought in front of the abdominal wall. Here a one-stage operation was done—resection and end-to-end anastomosis. The patient recovered.

"In some of these cases internal drainage (lateral anastomosis) at the first stage is commendable, *e g*, if patients object to the temporary colonic anus at the same operation. The surgeon will at the second operation often be surprised at the uniform adhesions that are found at the end of two weeks. However, they are easily separated and probably do not persist. One of his patients operated upon in this way more than ten years ago is perfectly well at the present time and has never complained of intestinal trouble.

"The artificial cæcal anus, made with the pointed Paquelin cautery and the McBurney incision, has proved very satisfactory in cases where it seemed indicated."

DR JOHN A. HARTWELL said that he wished to emphasize the statement made by Doctor Dowd that the operation of choice as these cases came for relief was the Mikulicz two-stage operation, but that if they came at an earlier period in their disease than is now the case, a great many of these cases could be operated by the one-stage operation. In the cases referred to in his statistics more than 60 per cent were either acutely obstructed, say, of two or three days' duration, or perforation of the growth had occurred with resulting abscess, before admission to the surgical ward, and in such cases some sort of drainage must be done at once. Where the condition is reached earlier and the growth is not too adherent and has not produced a complete obstruction, the one-stage operation can often be done. With reference to the statistics from the Mayo Clinic it should be borne in mind that a large percentage of these patients were not acutely obstructed. These cases come from a distance and are in fair condition on arrival, so that generally speaking the operation is not for an emergency condition, therefore, the statistics are not comparable with those resulting from emergency work, his own statistics had only to do with the carcinoma of the splenic flexure where the disease was deeply situated, very adherent and hard to get out. Doctor Hartwell inquired whether Doctor Dowd had found it an easy matter to bring up the two loops of the intestine with the growth outside the abdomen, and bring the efferent loop in close approximation to make a good double-barreled loop for later opening of the stoma.

DR CHARLES L. GIBSON said that although he had personally performed the Mikulicz operation only a few times, he believes if the operation is done under pretty sharp limitations that it is one of the best operations in surgery. He cited one case well at the end of seven years. In this case when the tumor was cut away the section showed deposits of cancer in the mesentery, and for this reason he kept the wound open for several months under the pretext to the patient to have it just right before closure. After cauterizing the area once or twice a week for several months it was closed. The Mikulicz operation is distinctly indicated in the second rather than in the first half of the colon. Doctor

Gibson believes it is a *sine qua non* to have a long spur. If one can refrain from opening the gut for from four to six days, such a procedure practically serves as a guarantee of the wound healing without sloughing or other trouble.

DR. CHARLES H. PECK believed the two-stage procedure to be the safest in many cases, although he did not agree that it should be used in all cases, since one meets with a fair number of mobile cases where if there is no considerable amount of obstruction and distention one can do an immediate closure with impunity. He recalled five cases during the last few years in which an immediate suture was done. One was in carcinoma of the transverse colon where there was a water-tight obstruction, there was a fecal fistula opening in the small intestine through which the intestinal contents passed for a number of months. In this case there was a very satisfactory immediate healing with no leakage or abdominal wall infection. Recently he had had an extensive adenocarcinoma of the sigmoid quite mobile, with enlarged inflamed glands, which seemed suitable for immediate excision and suture; there resulted a sharp abdominal wall infection but no leakage, and the infection was controlled within a few days. The healing of the gut was immediate and the patient was out of bed almost completely healed in four weeks. In 1910 he had a case in which immediate suture was done, protecting the wound by a drain. Doctor Peck in this relation was speaking altogether of the transverse and descending colon and not including cases in the ileocecal juncture and ascending colon, these are in a great measure one-stage operations. He referred to two further cases which healed after immediate suture. He believed there were a considerable number of cases sufficiently mobile where the gut was surrounded by enough peritoneum to warrant the one-stage operation. Here one can take a sufficient suture with cuffing over of one segment, protect it with adjacent fat or omentum, and thus be safe against intestinal leakage. He also believed that there are many cases in which the peritoneal covering was insufficient and where the danger of immediate closure was too great where the two-stage Mikulicz operation should be chosen.

DR. GEORGE WOOLSEY said that although he appreciated the value of the Mikulicz operation, he had always felt that if he could feel reasonably safe in a one-stage operation it had certain advantages. During the last several years he had seen a number of cases where the growth had not been acutely obstructing and where he had done the one-stage operation, though not always without slight local infection. He cited a case operated seven years ago for carcinoma of the descending colon where he had to open a small abscess in the loin, making a counter incision, with the patient well to-day, another case in the transverse colon was followed by no infection. He stated that in recent years he never had any leakage, which he considered due to the fact that he never does an end-

to-end suture in the large intestine, always using a lateral anastomosis, which he considered safe. Formerly he had had leakage in end-to-end anastomosis.

DR W S SCHLEY said that in reference to the immediate opening of the intestine in cases where there was obstruction, he felt it to be safe to use a large-calibre tube, suturing it into the proximal loop by two inverting purse-string sutures. In twenty-four hours peritoneum is quite tightly protected, and at the end of two or three days it is quite firm. He believes closure is easier at the end of four or five weeks after resection than at an earlier period, and safer.

DR JOHN DOUGLAS, in closing, in regard to the remarks of Doctor Dowd and Doctor Peck, who stated that in cases of carcinoma of the ascending colon and hepatic flexure the Mikulicz operation was not indicated, but that here the one-stage operation was the one of choice, agreed that it was only where there was acute obstruction that the one-stage operation was contra-indicated. He believed that if in his reported case he had done the one-stage operation there would have been a fatal issue.

DR CHARLES N DOWD (in closing), in answer to Doctor Hartwell's query whether it was a simple matter to bring out the intestine, said that it was not always an easy procedure, but that it was sometimes very difficult. The division of the outer leaf of peritoneum, which runs outward from the descending colon, is a very great aid, and sometimes permits an astonishing degree of mobility. So far the difficulty in mobilizing the intestine had not forced him to do a one-stage operation when he wished to do the two-stage procedure.

In reference to a clamp he had found an ordinary Kocher clamp satisfactory. He usually selected an old one, not too strong, loose in the joint, with a long jaw and a long ratchet.

He wished to make himself clear as to the degree to which he advocates the Mikulicz operation. As expressed in the last paragraph of his paper, it was not his purpose to advocate the two-stage operation for all cases, but to urge its value in the average case as it comes to the hospital. With regard to the one-stage operation, he, too, had had his share of successes. He cited four consecutive cases where immediate suture resulted in good recovery, with temporary leakage in two. Then came the fifth case with a fatal result which made a great impression. It was a man with cancer of the transverse colon whose fat was largely absorbed and in whom a one-stage operation seemed indicated, he made an end-to-end anastomosis without difficulty and apparently with good prospect of success, but the patient died within a few days. Enough of an autopsy was obtained to show that the two ends of the intestine had become gangrenous and had fallen apart. Apparently infection had involved the site of the stitches, and had led to breaking down of the suture line and consequent peritonitis. He believed that this result would not have

RETENTION APPARATUS FOR HARELIP OPERATIONS

followed if the two-stage operation had been done and if the intestine had not been opened until the growth was exteriorized and the peritoneal cavity shut off.

RETENTION APPARATUS AFTER HARELIP OPERATIONS

DR THEODORE DUNHAM stated that he had used various ways to hold the cheeks together in order to take the tension off and keep things at rest about the wound at harelip operations. The method which he now described answered better and promised better than any other method. He takes a piece of aluminum wire because it is very light, this is boiled with the instruments along with a pair of wire nippers and a file. He bends this wire, say about in the middle, so that it will have about the right curve to sit over the nose of the baby, he then bends two legs of it in a plane back to vertical to the plane in which the first bend was made, so that the two ends can come down alongside the nose. At the lower end just above the mouth he bends them straight up and cuts them off quite short to allow two little spurs at the end. He then wipes off the cheeks of the patient with alcohol and dries them, so that collodion will stick well, then takes a strip of silk muslin and passes it double around the end of the wire. Pressing the cheek up a little he fastens it with flexible collodion, following the same procedure on the opposite side. That allows the harpin of wire to hold the cheeks together, thus taking the tension off the scar. He steadies the wire where it comes over the root of the nose by another piece of silk muslin fastened at the root of the nose and forehead. This little apparatus produced no apparent discomfort and had proven very satisfactory.

DR WILLIAM A. DOWNES asked Doctor Dunham how often he found it necessary to use any type of appliance on harelips following operation, saying that, personally, he had used no appliance for the past four or five years. He called attention to Mr. James Berry's book on harelip and cleft palate in which it is stated that if there is a wide liberation of both sides of the lip there is practically never any necessity for a retention apparatus. Doctor Downes stated that he always used two layers of sutures, a catgut suture of chromic, including the mucous membrane and half the lip with the knot inside, then with a silk suture on the outside, including one-half the thickness of the lip.

DOCTOR DUNHAM, replying to Doctor Downes' question, said that he had always taken it for granted that the tension should be relieved by some method and therefore had never experimented without this in view.

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held December 1, 1919

The President, DR GEORGE G ROSS, in the Chair

USE OF FREE SKIN GRAFTS TO REPLACE LOSS OF MUCOUS MEMBRANE OF MOUTH AND NOSE

DR GEORGE M DORRANCE read a paper with the above title, for which see page 360

DR ROBERT H IVY said as to the success of the skin grafts in the mouth, such grafts had been used at the Walter Reed Hospital in some types of cases in which there was loss of mucous membrane. He showed four slides, giving a general idea of the operation and the appliances used in connection with it. The first showed a wire splint attached to the teeth with a loop to carry the modelling compound down into the buccal sulcus after the adhesions had been divided. The next slide showed the temporary appliance replaced by an artificial denture after the graft had taken. Another slide showed one of the grafts in the mouth. This was a case in which the upper lip was bound down to the jaw bone. An artificial plate bearing teeth was made of vulcanite. The scar tissue was then divided and the plate with its upper edge covered with the Thiersch graft was inserted and retained in the mouth for several days, by which time the free skin had become adherent.

DR JOHN B ROBERTS said that in carrying Thiersch epithelial grafts into the mouth, one of the difficulties is getting the graft to fit perfectly against the surface. If there is air underneath the graft, it is apt to fail to live. The important thing is to first have a model made of the surface in modelling compound, or wax, as Doctor Dorrance has used. The compound at ordinary temperatures is hard, but by moistening it with warm water it softens and, pressing it down to the surface, there results an exact negative. The skin side of the graft is placed against the negative which is then pressed into place and fits every little detail of surface. The important thing is to get the raw surface of the epithelium pressed right down upon the place where it is wanted to adhere and grow fast. This applies also in the eye socket or in ectropion operations for burns. As Doctor Dorrance and Doctor Ivy have said, it is of the greatest importance to have perfect contact of the raw surface of the Thiersch graft with the raw surface. It is easy to see that quick union will take place if the parts are not disturbed.

DOCTOR DORRANCE, in closing, emphasized the fact that he made the cavity larger than he expected it to remain. The plate is not removed for

FRACTURES OF THE PELVIS

three weeks after it is introduced. He particularly impressed this point also, because there have been many failures due to taking the plate out before this time.

OPERATIVE TREATMENT OF UNUNITED FRACTURES OF THE MANDIBLE

DR ROBERT H IVY read a paper with the above title, for which see page 363

DR A P C. ASHHURST said that, while on duty at the Walter Reed Hospital, he had many opportunities to watch the work of Doctor Ivy and of his predecessors, and was very much impressed with the amount of improvement which can be obtained by the combination of prosthetic and surgical skill. It is a long and tedious process to get these jaws sufficiently aseptic for an operation, in the second place, to overcome any deformity that may be there, and then to secure union, the final stage of the operation. From what he saw at the Walter Reed Hospital and in other places it is evident that there has been a very great advance in surgery of this kind during the war.

DOCTOR IVY, in closing, said that in these cases he felt that he must sometimes feel the ends of the bone with his gloved fingers. He did not touch the graft with his fingers, but he did not see how it is possible to keep the fingers absolutely out of the jaw wound. He had had no experience with the rib graft, but had seen cases later in which the operation had been done by Doctor Dorrance with uniformly good results.

FRACTURES OF THE PELVIS

DR WILLIAM J RYAN read a paper with the above title, for which see page 347

DR GEORGE G ROSS said that fracture of the pelvis when the femur is driven into the acetabulum, or so-called central luxation, is not such an uncommon injury. It occurs in three degrees. First, when the floor of the acetabulum is split, second, when the head of the femur is through the acetabulum, third, where the entire head has entered the pelvic cavity and the neck rests on the fractured edge of the acetabulum. It occurs as a result of force applied to the great trochanter, transmitted through the neck. There were several instances of this fracture in the hospital at Brest, and they all occurred as a result of falls down hatchways or from smokestacks. Some years ago such an injury came to him at the Germantown Hospital. Altogether there were six lines of fractures of the pelvis, one being central, luxation of the second degree. This case was treated by a circular band of adhesive plaster, taking in the pelvis and making pressure on the great trochanter. The patient made a very satisfactory recovery and is able to walk without support and without a limp.

DR HENRY R WHARTON expressed himself as much impressed with the high mortality in fractures of the pelvis mentioned by Doctor Ryan. His experience had been that the mortality of fractures of the pelvis, unless there are severe associated injuries, is rather low. He had seen cases recover in which there had been multiple fractures of the pelvic bones, with rupture of the bladder. He had recently under his care a case of fracture of the pubis, in which the patient had been caught between heavy pieces of iron and a wall, and in whom the urethra was torn from the bladder. Recovery occurred in this case after suprapubic cystotomy, retrograde catheterization, and perineal drainage. With regard to fracture of the pelvis in which the head of the femur is driven through the acetabulum, he had a case at the Presbyterian Hospital in which this occurred with other injuries in which the man made a good recovery. In this case, examination two years later showed that the patient walked easily and had no apparent shortening. With regard to the primary treatment, he had used a stout muslin binder, and, in some cases, plaster of Paris to immobilize the fracture. When the patient was able to get about he used a heavy canvas belt with straps and buckles to give good support in walking. He had been much impressed with the frequency of fracture of the pelvis in the last few years. It may be that routine X-ray examination discloses fracture of the pelvic bones formerly unsuspected.

DR A P C ASHHURST said that his experience agreed with what Doctor Wharton had said, that the mortality is not as high as the figures of Doctor Ryan would indicate, unless one considers only the cases diagnosed without the aid of skiagraphy. Looking up the records in the Episcopal Hospital about ten years ago, he found that the mortality was about 30 per cent (*Trans Phila Acad Surg*, 1909, xi, 225), but within the last few years he doubted if it much exceeded 10 per cent. Thirteen years ago, when he wrote an article on rupture of the bladder, he called attention to the danger of overlooking rupture if one injects so small a quantity as one pint. While he was a resident physician at the Episcopal Hospital, Dr Harry Deaver had a patient who had been injured in the abdomen. Doctor Ashhurst injected a pint of fluid into the bladder and all of it was recovered, nevertheless, at autopsy, an intraperitoneal rupture of the bladder was found. He made it a rule, therefore, to inject a quart, and sometimes even when one injects a quart, one may recover a quart and a half—showing that the fluid has gotten out of the bladder into the abdominal cavity, and that the catheter is draining the abdominal cavity. So that he has come to the conclusion that, unless the injected fluid causes the formation of a suprapubic tumor with the characteristics of a distended bladder, one cannot be sure the bladder is intact. He had come to the conclusion that in extraperitoneal rupture of the bladder, low down near its neck, it is safe to drain through the perineum. If there is a distinct rupture of the bladder easily found in the space of Retzius, one

FRACTURES OF THE PELVIS

would naturally drain there, but he was sure it is safer, where the lesion is deep in the pelvis and extraperitoneal, also to drain through the perineum

DR GEORGE P MULLER said that he had had two interesting experiences in connection with the diagnosis of rupture of the bladder by means of bladder injections. Several years ago, a patient was admitted to the University Hospital with the history of having been injured in the abdomen. A routine examination failed to show anything. He was catheterized and clear urine obtained, the interne stated that a measured amount of boric solution had been injected and recovered. Twenty-four hours later symptoms of peritonitis ensued and again he injected boric solution into the bladder and recovered the same amount. There was no blood. However, the abdomen was opened and a vertical tear in the bladder found exactly opposite the urethral orifice. They had been catheterizing the pelvic cavity. Recently, a case of fractured pelvis was admitted to the University Hospital, in which the symptoms of the ruptured bladder did not appear for twenty-four hours, at which time toxic symptoms were accompanied by a bulging mass above and to the right of the pubis. He had a tear in the bladder about $\frac{1}{2}$ inch above the urethral orifice and opening into the space of Retzius.

From his observations of certain of the cases reported by Doctor Ryan, together with other cases, he believed it would be best if they would develop a method of drainage through the perineum. Doctor Wharton has spoken with surprise of the mortality. As he remembered the fatal cases, most of them died within an hour or two from shock caused by the associated injuries, the remainder occurred weeks after from slow sepsis. In connection with this mortality should be remembered Doctor Moschcowitz's remark that "statistics from memory are often lower than statistics from analysis of case records."

DOCTOR JOPSON said that in the examination of these cases the importance of rectal examination should never be overlooked, both for diagnostic purposes, and to determine whether injury of the rectum is present or threatened by the presence of spicula. In fractures of the ramus of the pubis and ischium, there may be noted a reflex spasm of the adductor muscles of the thigh on the same side, as shown in movement of the thigh on the pelvis, which is of some diagnostic value. One of his former assistants, Dr Douglas P Murphy, devised an ingenious method of treatment for a case under their care, utilizing the principle of overhead extension. A heavy canvas sling, wide enough to include the entire pelvis and trochanters, was passed beneath the patient, a bar of corresponding length was passed through loops attached to the ends of the sling, and was attached in turn by cords to a longitudinal bar directly over the centre of the bed in a modified Balkan frame, the bar being only a short distance above the patient. In this manner the patient's pelvis was lifted clear of the bed, and the weight of his body furnished counter-pressure, which was conveyed through the sling to the sides of the pelvis.

and trochanters, pressing on them and effecting reduction and fixation of the vertically-separated fragments. This position was exceedingly comfortable, and the care and nursing of the patient were much simplified. The result was entirely satisfactory, and the method was a decided improvement over that which we were accustomed to use, *viz*, circular compression and support by a heavy duck binder, fastened by straps and buckles, or pinned around the pelvis.

DR D B PFEIFFER said that he saw a case this summer, in the service of Doctor Wharton in the Presbyterian Hospital, which illustrated the statement made by Doctor Ryan that certain cases need drainage in anticipation of suppuration, and the further report of one case which did show suppuration and sepsis presumably secondary to infection of a hæmatoma. The case referred to was a young man who had been brought to the hospital after an accident in which he had been struck by a trolley car while in an automobile and rendered unconscious. He soon regained consciousness and was brought to the hospital in an ambulance. He was placed in bed and examined by the interne, who found nothing alarming in his general condition but suspected an injury of the pelvis. The patient did not seem to be in pain. In a short time, however, he began to complain of pain in the lower abdomen, which became more and more severe. The temperature remained approximately normal, but the pulse rate had risen markedly, being about 140 per minute and of poor quality. The face was pale and the expression anxious. The abdominal muscles over the whole lower abdomen were tense and pressure was painful. Dullness over this area was pronounced. Any motion or disturbance of the pelvis was painful and it was concluded that a fracture existed. There was no blood in the urine. The probability of hæmatoma formation, as a cause of the general and local symptoms above stated, was considered. However, the intensity of the abdominal symptoms, together with the existence of a contused abrasion of the abdominal wall above the symphysis, suggested an intra-abdominal injury. The abdomen was opened through a right rectus incision. On splitting the fibres of the rectus, the preperitoneal tissue was seen to be infiltrated with a huge amount of blood which was for the most part held in the meshes of the areolar tissue. However, between the peritoneum and the region of the internal aspect of the acetabulum on the right side there was a cavity filled with approximately 250 to 300 c c of blood clot. This was evacuated and with the finger a complete fracture of the superior ramus of the pubis was felt. Active hemorrhage seemed to have ceased. The peritoneum was opened and no visceral injury found. The pelvic cavity was not more than half its normal size, due to the massive subperitoneal infiltration which surrounded it on all sides. A rubber tube was placed just through the abdominal wall into the preperitoneal space and the wound closed. Considerable serosanguinous exudate drained for three days, when the tube was removed. Healing and recovery were unevent-

FRACTURES OF THE PELVIS

ful. It is probable that in this case there was a direct rupture of a vessel of considerable size, and while he would not have operated for this reason alone, there can be no doubt that the danger of infection of the hæmatoma was materially lessened by the evacuation of the clot and drainage of the preperitoneal space under all aseptic precautions

DR WALTER G ELMER reported a rather unusual type of injury in a boy who was admitted to the Orthopædic Department of the University Hospital for tuberculosis of the hip. X-ray examination revealed that the head of the bone had been driven through the floor of the acetabulum and tuberculosis of the hip had followed

DOCTOR RYAN, in closing, remarked in regard to the mortality, which, according to Doctor Wharton and Doctor Ashhurst, seems to be high, that three patients died within two hours of their admission, one in three hours and one in thirty hours

CORRESPONDENCE

SURGICAL ENGLISH

EDITOR, ANNALS OF SURGERY

I have just finished reading the February number of the ANNALS OF SURGERY. On one page I find once the sentence, "On ——— she was *operated*," and on a subsequent page I found twice the same error repeated in the sentence "These cases should be *operated* and *operated* early." Of course, they should read, "*operated on*" or "*operated upon*." When we typewrite a letter we "operate" the machine. If we repair it, we should, so to speak, "operate on" or "upon it."

Such misuse of the English language, especially by some of our foremost surgeons, is very deplorable. I trust that by calling attention to this increasing misuse of the language these faults may be corrected.

W W KEEN

THE ANNALS OF SURGERY takes pleasure in calling attention to the above protest. The Editor has admitted the objectionable phrase, though not without some mental misgiving, from a feeling that there was a real call for such an extension of usage in the verb in question, and that since the English tongue was still a living one and undergoing constant changes, this might be one of those that were allowable and desirable.

L S P

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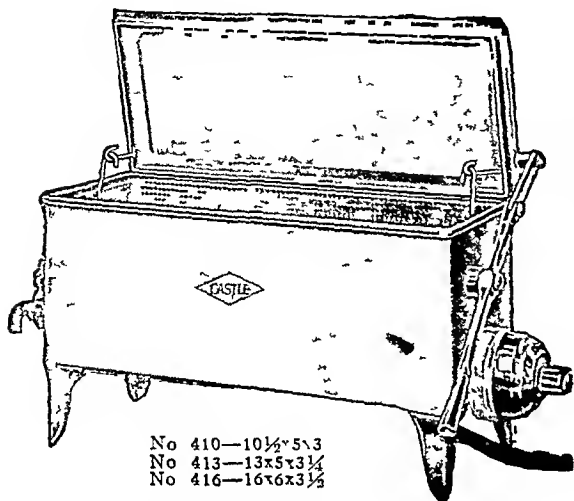
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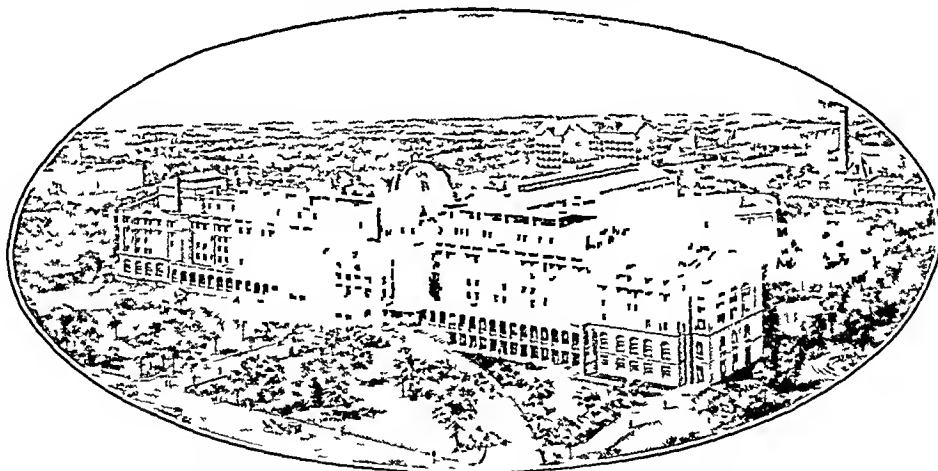
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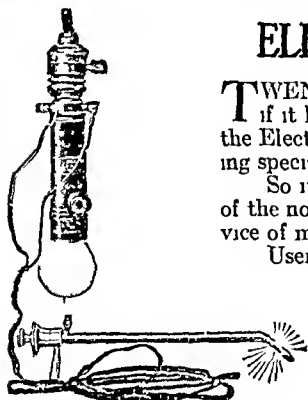
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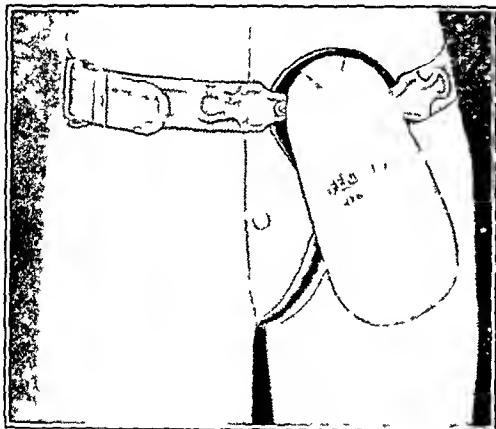


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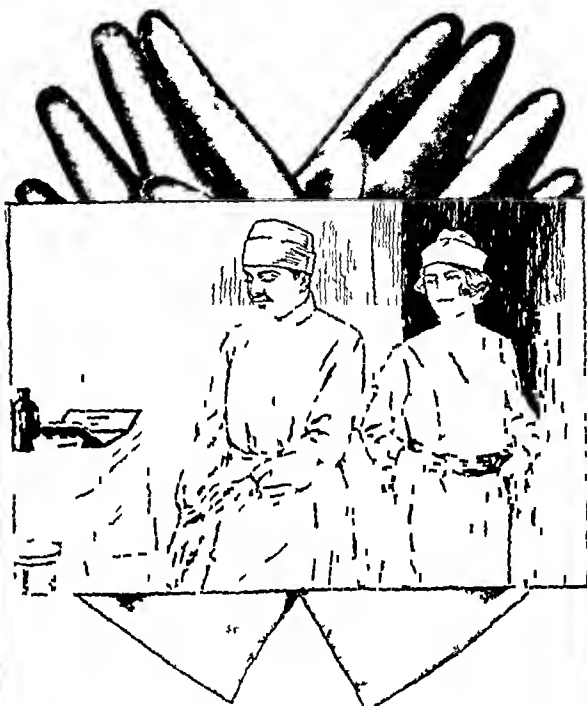
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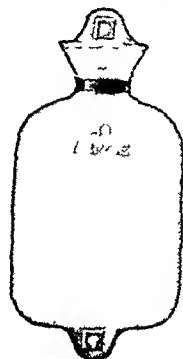
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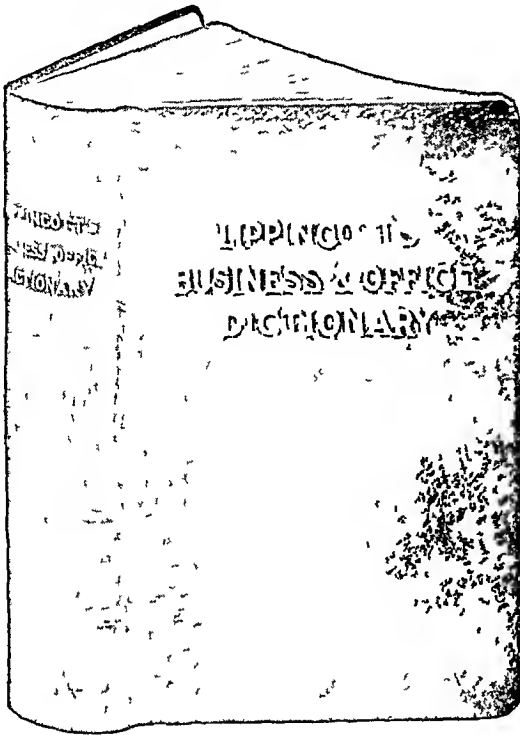


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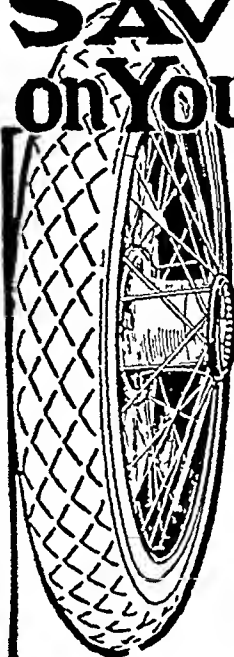
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31x4	18.30	20.75 4.25	35x5	30.90	33.80 6.95
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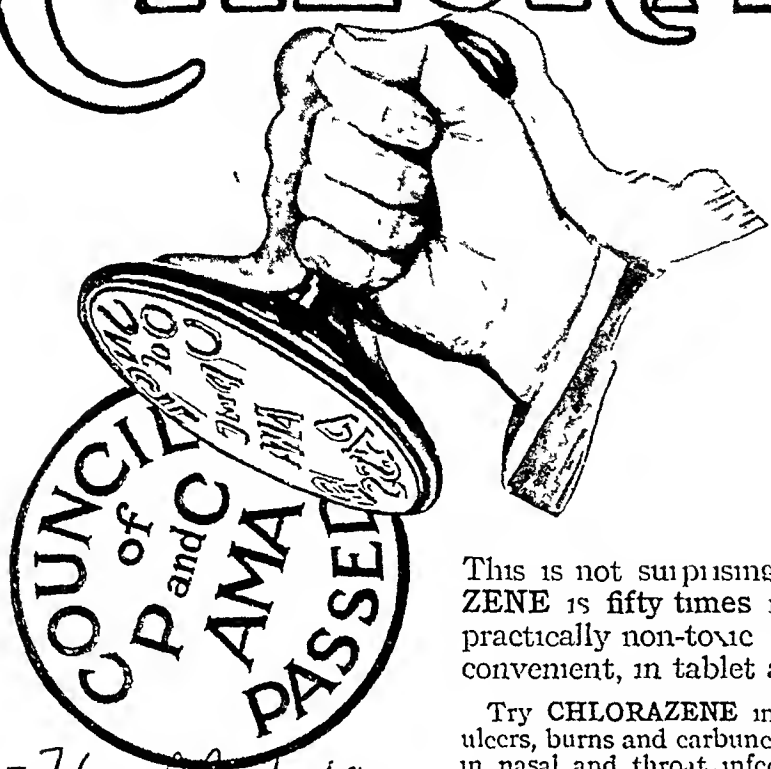
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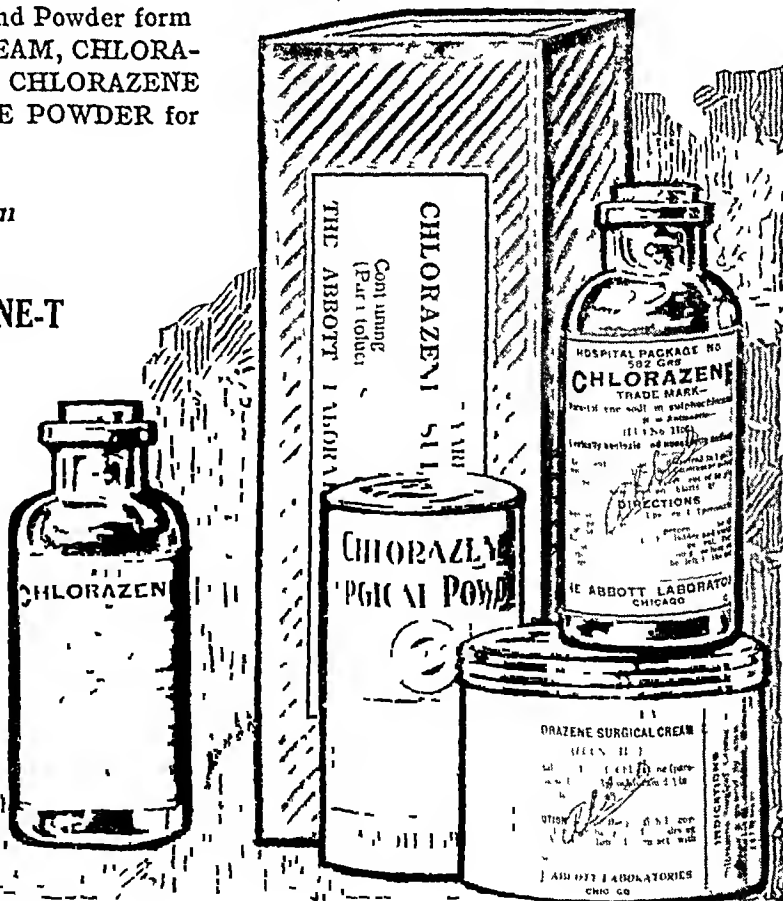
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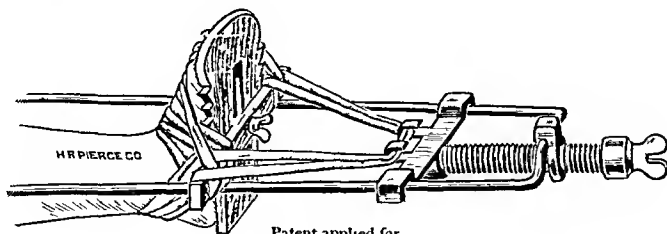
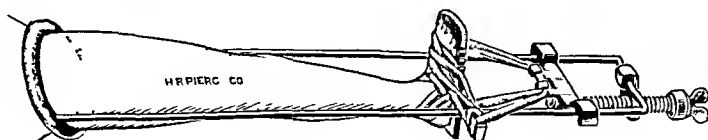
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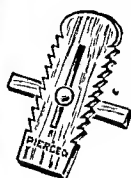


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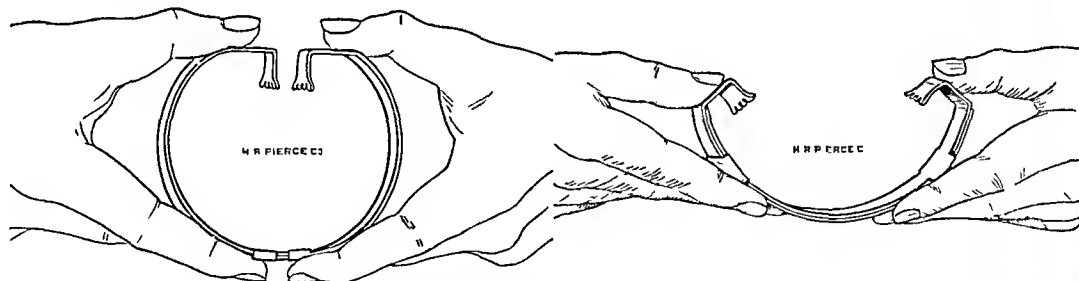
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Boilable

CLAUSTRO-THERMAL, meaning *enclosed heat*, is descriptive of the improved method of heat sterilization. The principle of the method consists in applying the heat after closure of the tubes, thus avoiding all the chances of accidental contamination.

The sealed tubes are submerged in a bath of cumol—the high boiling hydrocarbon. The temperature of the cumol bath is gradually elevated until at the end of six hours the maximum of 165° C (329° F) is reached. This temperature is maintained for five hours, and is then allowed slowly to decline. The temperature curve is graphically represented by the chart shown below.

It is obvious, therefore, that sterility is absolutely assured. The sutures, being stored in their original tubing fluid and reaching the surgeon's hands sealed within the tubes in which they were sterilized, are removed from all the chances of contamination incident to the customary method of sterilizing the strands in open tubes.

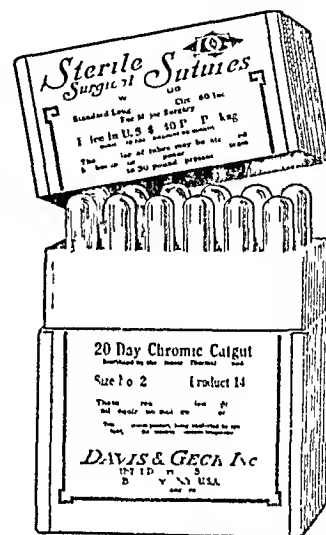
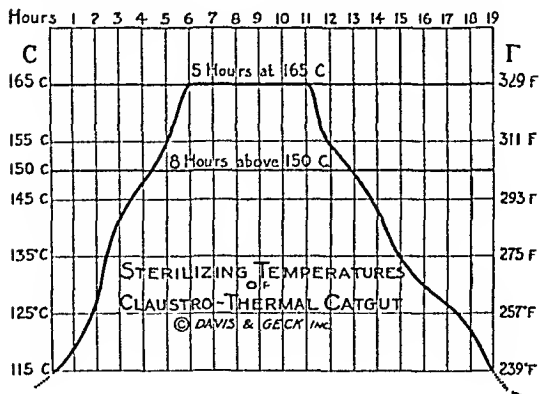
Sterilization by this integral method is made feasible through the use of toluol as the tubing fluid. The discovery of the value of toluol for this purpose was the outcome of an investigation aimed at finding a suitable fluid to replace chloroform. The latter was formerly in general use, but was unsatisfactory because it was found to break down into chemical products which not only exerted an extremely harmful action on the collagen of the sutures but which were responsible for considerable wound irritation.

No other mode of sterilization so completely fulfills the exacting requirements for the production of ideal sutures as does the Claustro-Thermal method. Through its use the natural physical characteristics of the strands are preserved, while the destruction of all bacterial life is absolutely assured.

Claustro-Thermal sutures are not impregnated with any germicidal substance, and consequently they exert no bactericidal influence in the tissues.

This product embodies all the essentials of the perfect suture, such as compatibility with tissues, accuracy of size, maximum tensile strength, perfect and dependable absorbability, and absolute sterility.

Reprints of original articles relating to the Claustro-Thermal method will be sent upon request.



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10-Day Chromic Catgut	Product No 125
20-Day Chromic Catgut	Product No 145
40-Day Chromic Catgut	Product No 185

SIZES 000 00 0 1 2 3 4

Claustro Thermal sutures are unaffected by age, light, or extremes of climatic temperatures.

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Kalmerid Catgut

An Improved Germicidal Suture Superseding Iodized Catgut

KALMERID CATGUT is not only sterile, but, being impregnated with potassium-mercuric-iodide—a double iodine compound—the sutures exert a local bactericidal action in the tissues. The older practise of impregnating catgut with the ordinary crystalline iodine for this purpose was at best an unsatisfactory method, since the antiseptic power was but slight and transient. The most serious deficiencies of such iodized sutures, however, were their instability and weakness arising from exposure to light, the deterioration resulting from the continuous and unpreventable oxidizing action of the iodine, and the disintegration of the sutures when heated. Moreover, the decomposition products of iodine caused such sutures to be irritating.

These serious disadvantages of iodized catgut have been overcome through the use of potassium-mercuric-iodide instead of iodine. This double salt of iodine and mercury, the chemical formula of which is $\text{HgI}_2 \cdot 2\text{KI}$, is one of the most active germicides known, exerting a killing action on bacteria about ten times greater than that of iodine. It does not break down under the influence of light or heat, it is chemically stable, and, in the proportions used, is neither toxic nor irritating to the tissues. It interferes in no way with the absorption of the sutures, and is not precipitated by the proteins of the body fluids.

Kalmerid catgut, in addition to its bactericidal attribute, embodies all the essentials of the perfect suture. It is perfectly compatible with the tissues, its absorbability is dependable, and its tensile strength is particularly good.

TWO VARIETIES—To meet the requirements of different surgeons two kinds of Kalmerid catgut are prepared—the boilable, and non-boilable.

BOILABLE GRADE—This variety is prepared for surgeons who prefer a boilable suture such as the Claustro-Thermal product, but possessing bactericidal properties in addition. The boilable grade, therefore, besides being impregnated with potassium-mercuric-iodide, embodies the desirable physical characteristics of the Claustro-Thermal sutures. It has the same moderate degree of flexibility, it is the same in appearance, it is tubed in the same improved storing fluid—toluol, and, after impregnation with potassium-mercuric-iodide, it further receives the Claustro-Thermal sterilization—that is, heat sterilization after closure of the tubes.

NON-BOILABLE GRADE—This variety is extremely pliable as it comes from the tubes. It is made for those surgeons who have been accustomed to the flexibility of iodized catgut.

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20-Day Chromic	Product No 1245	20-Day Chromic	Product No 1445
40-Day Chromic	Product No 1285	40-Day Chromic	Product No 1485

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Kalmerid Kangaroo Tendons

Two Varieties—Boilable and Non-Boilable

THESE are the sutures *par excellence* for those procedures in which post-operative tension is excessive, or long continued apposition necessary, such as in herniotomy, and in tendon and bone suturing. Kalmerid kangaroo tendons not only are sterile, but, in addition, they are impregnated with potassium-mercuric-iodide, which enables them to exert a local bactericidal action in the tissues. The impregnating and sterilizing methods are the same as practised in the preparation of Kalmerid catgut, and described on the preceding page.

They are genuine kangaroo tendons, they are round, smooth, straight, of uniform contour, and possess a tensile strength about twice that of the best catgut of equivalent size.

Because of their greater strength some surgeons prefer these tendons, particularly in the finer sizes, to catgut for general intestinal, muscle, fascia, and skin suturing.

ABSORPTION TIME—The tendons are chromicized, and so accurately is the chromicizing process regulated that each size, whether it be the finest or the coarsest, will maintain apposition in fascia or in tendon for approximately thirty days. Shortly after that period the sutures, with their knots, will be completely absorbed.

TWO VARIETIES—Kalmerid kangaroo tendons are prepared in two grades—boilable and non-boilable. The **NON-BOILABLE** tendons are extremely pliable and consequently require no moistening.

The **BOILABLE** tendons are quite stiff as they come from the tubes, but may be rendered pliable by moistening in sterile water preliminary to use. The smaller sizes will be sufficiently softened by fifteen minutes immersion, while the larger sizes should be immersed for about thirty minutes. Either sterile water, or an aqueous bactericidal solution made with Kalmerid tablets—1 5000—should be used.

Before immersion, the toluol, which is very volatile, should be allowed to evaporate so that the water may have access to the sutures.

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Each Tube Contains One Tendon ~ Lengths Vary From 12 to 20 Inches

The Non-Boilable Grade is *Product No 370*

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~ Sizes ~

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00	_____
0	_____
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2	_____
3	_____
4	_____
6	_____
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360	Horsehair	Four 28-inch Sutures	00
390	Plain Silkworm Gut	Four 14-inch Sutures	00, 0, 1
400	Black Silkworm Gut	Four 14-inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
480	White Braided Silk	60 Inches	00, 0, 2, 4
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Product No	Material	Approximate Quantity in Each Tube	Catgut Sizes
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812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-inch Sutures	00
872	Plain Silkworm Gut	Two 14-inch Sutures	0
882	White Twisted Silk	20 Inches	000, 0, 2
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With Needles as Illustrated

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Product No	Material	Approximate Quantity in Each Tube	Catgut Sizes
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914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-inch Sutures	00
974	Plain Silkworm Gut	Two 14-inch Sutures	0
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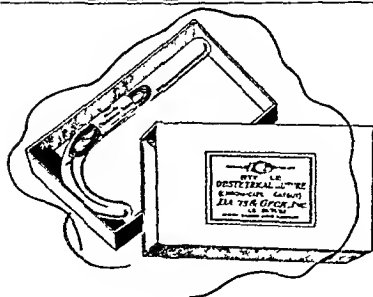
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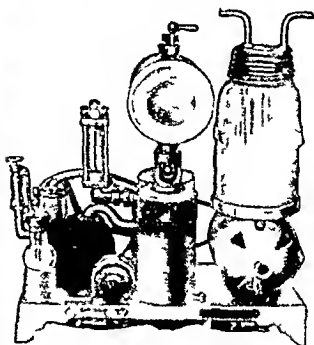
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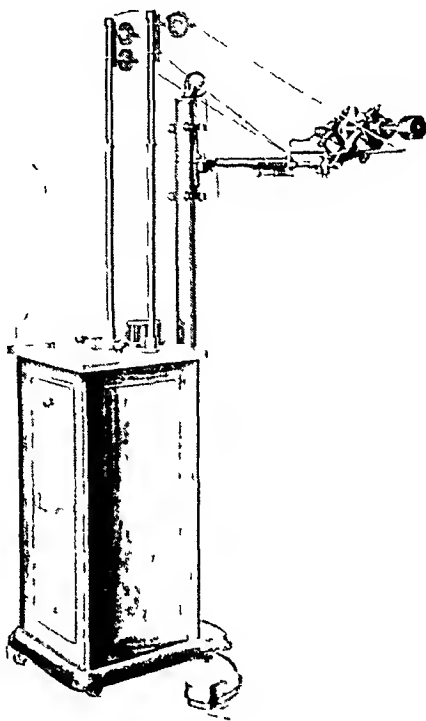


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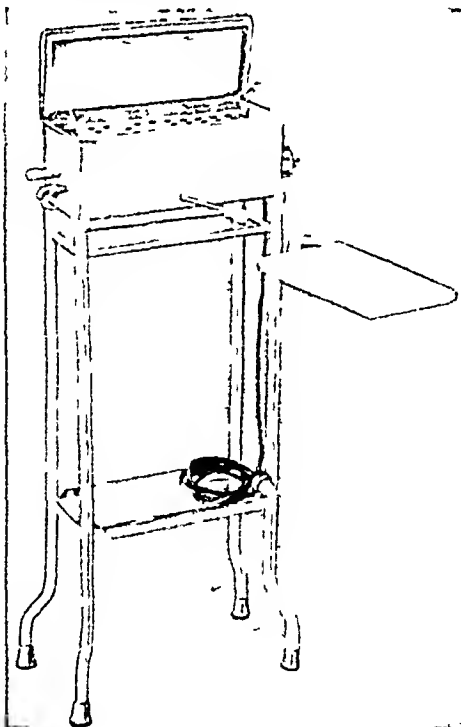
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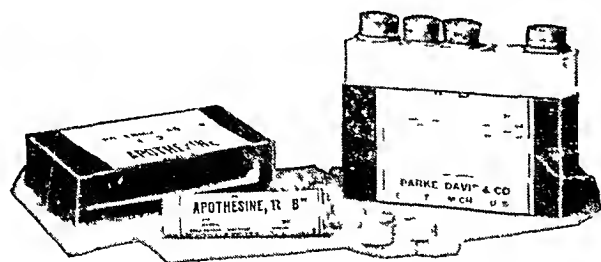
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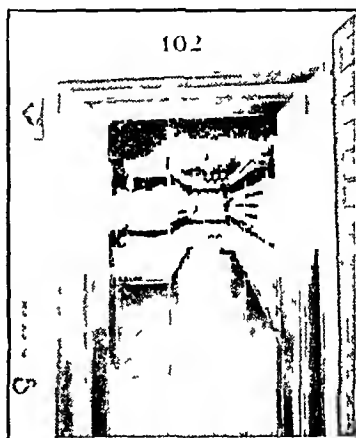
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SOME EXPERIENCES AND OBSERVATIONS IN THE TREATMENT OF ARTERIOVENOUS ANEURISMS BY THE INTRASACCULAR METHOD OF SUTURE (ENDO-ANEURISMORRHAPHY) WITH SPECIAL REFERENCE TO THE TRANSVENOUS ROUTE *

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I RENEWED interest in the treatment of arteriovenous aneurisms has been roused by the great frequency of these lesions in the experience of the late World War. The coincident injury of the artery with its companion vein or with its satellites has long since been recognized by military experts as one of the most frequent and characteristic injuries of the blood-vessels in modern warfare. But the late war has exceeded the records of all previous wars in the frequency of vascular injuries, and especially those of the bivascular type. The increasing incidence of vascular injuries was foreshadowed by the records of the Balkan campaign of 1912-1913 which immediately preceded the World War, but even the incomplete contributions from the military surgeons of the belligerent armies which have appeared in the surgical literature during the last four years would indicate that the incidence of these injuries, and especially of the arteriovenous lesions, has exceeded by far any forecast based upon the experience of previous wars.¹ This increase is

* Read before the Southern Surgical Association, December 16, 1919

¹ Pirogoff, one of the greatest military surgeons, admitted in 1864 that he had never seen a single case of arteriovenous aneurism that had been caused by gunshot wound, and this statement was in accord with the statistics of all the older wars. Thus we find Demme (1859), who served in the Italian campaigns, recorded 400 wounds of the blood-vessels without seeing a single arteriovenous aneurism. In 74 cases of traumatic aneurisms no arteriovenous aneurisms were recorded in the American Civil War (1860-64), nor in the Russo-Turkish wars (1877-78). During the Franco-Prussian War (1870-71), out of 44 traumatic aneurisms, only 8 arteriovenous cases are recorded on the German side. Bramman in his classic paper on arteriovenous aneurisms (1886) gives a brief description of 4 of these, which are included in his total of 157 arteriovenous aneurisms, 36 of which, or 40 per cent, were caused by phlebotomy. (E. Fergue, *Rev. de Chirurg.*, Tome 54, II, p. 1.)

With the advent of the hard-jacketed, high-velocity projectile and small-calibre rifle, the history of war aneurisms begins as a conspicuous feature of warfare. Traumatic aneurisms, including the arteriovenous, became familiar injuries in the South African, Spanish-American Wars and in the Philippines.

They figured still more in the Russo-Japanese War, and constituted nearly 2 per cent of the total wounds in the Balkan conflict in 1913, which immediately preceded the late war.

accounted for by the great preponderance of the artillery and machine-gun fire, in which shrapnel, fragments of explosive bombs, shells, hand grenades, and the pointed bullet of the machine gun have had unprecedented sway as vulnerating bodies² Some idea of the great frequency and importance of these vascular injuries can be gathered from the fact that in a single British casualty clearing station, during the early days of the first battle of the Somme, there were 277 wounds of individual vessels which, according to Hey and Bowlby, required special treatments (Bowlby, *British Med Jnl*, June, 1917, vol 1, p 707) Okinczyc (*Jnl de Chirurgie*, 1917, vol xiv, p 441), writing of his experience with a French ambulance at the front, reports that 24.7 per cent of the wounded required special attention for injuries of the blood-vessels, and that in 36 per cent of these the injuries were multiple, involving usually the arteries and veins Gerulanos on the German side (*Beitrag z klin Chirurg*, Bd 93, 1914-15) reported that of 2522 wounded soldiers who were brought to him at the base, 50, or only 2 per cent, required special attention for gunshot wounds of the large blood-vessels In the military hospitals at the base the effect of the first-aid treatment at the front and in the lines of communication at once lowered the proportion of gunshot wounds of the blood-vessels to about 2 per cent

R Solomon (*Beitrag z klin Chirurg*, 1918, vol cxii, pp 369-410), reporting the German experiences at Frankfort, in Rehn's Hospital, states that in a total of 25,000 wounded, 490, or 1.96 per cent, were admitted for gunshot wounds of the blood-vessels

In regard to the increased frequency of the arteriovenous aneurisms, Sir George Makins ("Gunshot Injuries of the Blood-vessels," London and New York, 1919) in an analysis of 272 traumatic (war) aneurisms, admitted to the London hospitals, found that 120 were arterial and 152 were arteriovenous, and that of the latter, 52, or a little over half, were simple or direct aneurismal varices He, in accordance with the majority of observers, finds that these bivascular or arteriovenous injuries occur with greatest frequency (at the base hospitals) in the carotid, femoral, pop-

²Chalier and Glenard (*Les Grandes Blessures de Guerre*, *Rev de Chirurgie*, T 51, January-June, 1916, p 210) in an exhaustive study of 1500 wounded under their care at the front during November, 1914, to February, 1916, carefully recorded the nature of the vulnerating agent and found that a little over 50 per cent of these were caused by rifle bullets, including machine-gun fire, and the artillery projectiles 42 per cent (fragments of shells, 539, shrapnel, 73, caving in of trenches and shelters by bomb explosives, 16, and other causes attributed to artillery fire, 6, equals 634 cases, or 42 per cent) Subsequently after the date of their publication they note that the proportion of artillery projectiles greatly increased as the war advanced There were only 7 cases of bayonet wounds Bier and Kuttner make the same observation on the German side

In comparison, we find that in the Russo-Japanese conflict the casualties caused by small arms and bullets on the Japanese side were 83.5 per cent, by artillery projectiles, 13.5 per cent On the Russian side, small-rifle bullets caused 84.5 per cent of the wounds, artillery and explosive projectiles, 14.5 per cent

TREATMENT OF ARTERIOVENOUS ANEURISMS

liteal, and axillary tracts—though at the front the tibial vessels are most frequently injured (26.6 per cent), but as these occur coincidentally with other complicating injuries (fractures) they are treated at the front and thereby eliminated from the base hospitals. The great excess of arteriovenous injuries in the neck is shown by the fact that of 57 aneurisms, 10 were arterial and 47 arteriovenous, or about 80 per cent arteriovenous. And of the latter, 49 were varicose and 18 aneurismal varices. In the femoral group (common, superficial, and profunda), 170 injuries are recorded, of which 30 per cent were arteriovenous. In the 41 recorded in the popliteal group, 20 were arterial and 21 arteriovenous. Of this group, 17 were varicose aneurisms and 4 aneurismal varices.

Swan (1917) recorded 176 war aneurisms, of which 40 were arteriovenous, roughly 38 per cent arteriovenous.

W. McAdam Eccles (1916) reported 50 traumatic aneurisms, of which 30 were arterial and 20 arteriovenous.

Soubbotich (1916), as the result of his large experience with the Serbian army, found a preponderance of arterial aneurisms. Of 126 aneurisms, 84 were arterial and 42 arteriovenous.

Bier reported, early in the war (1915), 102 aneurisms, of which 45 arterial and 56 arteriovenous were operated upon. The arteriovenous predominated in the femoral tract, where the proportion was 33 arteriovenous to 28 arterial.

Kuttner (1916) stated, in his large experience, that the relative proportion was 45 per cent arterial and 55 per cent arteriovenous.

Hotz states his proportion of arteriovenous as 70 per cent of the total number.

In a general way, it may be safely stated that of the traumatic war aneurisms, fully 50 per cent involve both the artery and the satellite vein, and furthermore, that in fully 50 per cent of the arteriovenous aneurisms the communication established between the vessels is of the simple *direct* fistulous type (aneurismal varices), and that in the remainder the wounded vessels communicate *indirectly* through a pseudo or adventitious sac.

It is well to note that while the great preponderance of artillery and explosive projectiles, fragments of shells, etc., has been responsible for the increase in the war wounds of the blood-vessels, it would appear that the greatest number of these, and especially of the bivascular injuries (particularly the direct arteriovenous fistula), are caused by the small pointed rifle or machine-gun bullets.

In the neck, Makins found that in 60 recorded injuries of the carotid vessels, 22 were caused by bullets and 38 by fragments of shells or bombs, often of very small size, which were retained in the tissues or in the pseudo-aneurismal sacs.

R. Solomon (1918) states that the pointed rifle bullet was responsible for 81 per cent of the traumatic aneurisms observed in the Frankfort Clinic,

of which 82.5 per cent were through-and-through perforations, and 17.5 per cent were complicated with retained missiles

By reviewing the general (German) literature of the war, Solomon finds that 74 per cent of the traumatic aneurisms were caused by rifle bullets, and in 14 per cent of these the missile was retained. Shrapnel was the cause of the aneurisms in this author's series in 55 per cent, in 29 per cent of which the missile was retained, in 11 per cent of the aneurisms caused by fragments of grenades and bombs, fragments were retained in 57 per cent. Only 4 per cent of the aneurisms were caused by punctured (bayonet, sword) wounds, and *contusions* were responsible for 20 per cent, though in the general literature, contusions are credited with only 1½ per cent.

Donati (1917), basing himself on a much smaller Italian experience limited chiefly to the extremities, estimates that 40 per cent of blood-vessel injuries were caused by rifle bullets.

From all of which we gather that the largest number of aneurisms are caused by the small rifle bullet when it speeds through the tissues with high velocity, leaving only a clean-cut, tunnelled perforation. On the other hand, the fragments of shells or explosive projectiles of low velocity are *retained* in the tissues in about 57 per cent of the cases.

* * * * *

II It is not my purpose in this contribution to enter into a general discussion of the subject of arteriovenous aneurisms, or even attempt a systematic account of the methods of surgical treatment, especially as developed in the experience of the great war. Such an attempt would carry us far beyond the scope of this publication, which is intended to renew attention to the frequency and growing importance of a vascular injury which has become more than ever one of the most conspicuous features of the surgery of modern warfare.

I have, elsewhere, treated this very interesting lesion in its manifold and general phases (see *Vascular Surgery*, Chapter lx, vol. v, *Keen's Surgery*) and have dealt more fully with the developments consequent upon the vast experience of the late war in a general review of the war surgery of the heart and blood-vessels, which is to appear in a forthcoming supplementary volume of *Keen's Surgery*, now in press.

My object in this paper is to give a brief account of a group of personal experiences which illustrate the practical application of the intrasaccular method of suture, which I have so long devised and advocated for the cure of arterial aneurisms (endo-aneurismorrhaphy), and found equally advantageous in the cure of the most frequent types of the bivascular or arteriovenous aneurisms.³

III There is no single method or technic that is applicable to all

³ Much of the text which follows is a transcript of an article contributed to the Osler Anniversary Memorial Volume, and is here reproduced by permission of the Editors.

varieties of arteriovenous aneurisms as these are met in practice. There are, and always will be, cases in which the conservative principle of the suture, which aims at the restoration of the functional integrity of the blood-vessels, will have to yield, in the presence of insurmountable and forbidding anatomical and pathological conditions, to the radical methods of ligation and extirpation, which are to be regarded as conservative whenever they accomplish their purpose (cure) without sacrifice of limb or life. But the experience of the author confirms the opinion that by the adoption of new technical suggestions, such as exhibited in this paper, the opportunities for the application of a conservative technic can be much enlarged, thereby reducing very considerably the number of radical ligations and extirpations which are undoubtedly performed with unnecessary frequency and severity in the current practice of the day.

It would be well to premise a further consideration of this subject by stating that in dealing with the later suggestions presented in these personal experiences, we have in mind the treatment of the fully formed or established types of the mature arteriovenous lesions as distinguished from the primary or recent wounds of these vessels, when the question of primary hæmostasis for hemorrhage or the relief of rapidly spreading hæmatomas is the first consideration. Even in these, the principle of conserving the functional integrity of the injured vessels is to be seriously considered, and can be successfully met, in many instances, by the devices of conservative practice—such as end-to-end suture of the vessels, vascular grafts and intubation with paraffined glass or metallic tubes (Brewer's, Tuffier's, Lespinasse's *et al*). But the technical problems are very different from those offered by the mature or established arteriovenous aneurisms, with which we are now concerned.

* * * * *

If we were to study closely the morphology and pathological anatomy of the mature and fully established arteriovenous aneurisms, we would probably be able to differentiate more than fifteen varieties. These, however, can be grouped about the two fundamental types, which have been classical since the days of Hunter and Scarpa. These are the *aneurismal varix* (varix aneurysmaticus), and the *varicose aneurism* (aneurysma varicosum). The aneurismal varix, with its subvarieties, typifies the *direct* mode of arteriovenous anastomosis, the varicose aneurism, the *indirect* communication between the two vessels, through a common intermediary or "communicating" sac. In the aneurismal varix the arterial and venous wounds become agglutinated and adherent as a direct inosculation, following as an immediate or early sequel of the injury and an arteriovenous fistula is established after the small perivascular extravasation has been absorbed. Two important subvarieties of this type must be distinguished. (1) The true aneurismal varix which presupposes a varicose dilatation of the vein, constituting the true sac of

the aneurism, and which, owing to the progressive dilatation of the vein, may attain enormous proportions, not only at the seat of the anastomosis, but in older cases, far beyond the proximal and distal sides of the abnormal communication, owing to the yielding and incompetence of the valves, and (2) the simple arteriovenous fistula (*phlebartery* of Broca) in which there is no varicose dilatation except a general symmetrical enlargement or ampullar formation of the vein at the site of the fistula, where the dilatation is confined by the resistance of competent valves.

In the *varicose* aneurism, as *classically described*, the normal anatomical position of the vessels is disturbed, they do not lie side by side as in the aneurismal varices. The injury is followed by more or less extensive hemorrhage, which, being circumscribed by the resistance of the perivascular tissues, forms a well-defined pulsating hæmatoma and finally an encysted and clearly differentiated and well-walled sac, which is lined with endothelium continuous with that of the open mouths of the blood-vessels.

As above stated, it is customary to describe a varicose aneurism as an intermediary pseudo-sac formed adventitiously and interposed between the injured vessels, through which an indirect communication is established between the artery and vein. But contrary to this teaching all surgeons of experience will agree that the formation of this *intermediary* sac is an exceptional occurrence, whereas the presence of a well-defined sac into which the injured vessels open *separately* without any disturbance in their anatomical relations—the two vessels lying side by side—is a common occurrence. On opening such a sac and evacuating the clot, the two vessels will be seen at the bottom or at some part of the periphery of the cavity, plainly in relief, or faintly outlined under the fibroendothelial capsule, which, in old aneurisms, covers them like a veil. The orifices indicating the original seat of injury will show themselves in various ways, either as elliptical or slit-like openings lying parallel to each other, or in a quadruple group, two proximal and two distal, separated by an interval of variable length. The proximal orifices represent the cardiac and the distal the peripheral ends of the divided vessels. These different appearances depend upon the extent of the primary injury—whether a partial or a total division of the vessels is involved in the trauma. In some rare cases in which the vessels have been completely divided, there are, as Amussat first observed, only two recognizable openings leading into the sac, one for the artery and one for the vein, which indicate the cardiac or central ends of the divided blood-vessels, the peripheral ends having been occluded by organized thrombi and finally lost in the wall of the sac. It is more frequent, in our experience, to see a type of varicose aneurism, following partial division of the vessels, in which there is a common, fairly large sac, which when opened exhibits a smaller pocket formed by the sheath of the vessels. In the centre of this smaller cavity four orifices appear in close proximity, showing that the vessels have been injured tangentially and

simultaneously, either by stab or shot, causing no disturbance in their relations as they lie side by side in perfect apposition. The four orifices lie parallel to each other, two above and two below, and open directly into the smaller sac formed by the sheath which has been torn open, leaving a circular or elliptical opening which merges in its contour with the larger pseudo-sac formed by the primary hæmatoma (Figs 2 and 3, illustrating the case of Walter E.)

The margins of the orifices in all types of arteriovenous aneurisms of mature formation (six or eight weeks and over) are usually thick and smooth and are covered by a glistening endothelium which merges and is continuous with the endothelial lining of the cyst-like cavity of the sac. The same blending or merging with the endothelial lining is observed in the fistulous communications existing in the direct arteriovenous lesions, a matter of importance, as this thickened and firm lining offers an excellent grip for the sutures which obliterate the anastomotic communications.

Another and most troublesome, but rarer, type is the arteriovenous aneurism in which the artery has been injured simultaneously with its two satellite veins. In these cases a venous sac or ampulla is formed on each side of the artery. The two venous sacs are usually asymmetrical, according to the different planes of resistance encountered in their development, one of these attaining large proportions and the dimensions of the other being only moderate.

In stab or punctured wounds the adventitious or common sac lies, usually, in front of the vessels, and in the gunshot wounds the sac more often lies behind them.

The following diagrams (Fig 1), modified from Sir George Makins' "Gunshot Injuries of the Blood-vessels, 1919," give a clear idea of the relations of the blood-vessels to each other and to the adventitious sac, as they would appear on cross-section. They are in perfect accord with the clinical findings, not only as carefully studied in "war aneurisms" by Makins, but with the morphology of these aneurisms as observed by the writer in his civilian experience.

In other still rarer cases, more often met in civil practice (hunting accidents), and fortunately limited, usually, to the peripheral vessels of a secondary order (upper extremity), are those in which an artery of smaller magnitude is injured simultaneously with its *venæ comites* at many places by fine shot. In these cases, the condition imitates cirroid aneurism, and the arteries and veins are mixed up in such inextricable confusion that extirpation is the only remedy, fortunately, they seldom attain dangerous proportions or cause serious disabilities and can be safely allowed to remain undisturbed.

Arteriovenous aneurisms with an *arterial* sac, in which the aneurism ruptures secondarily and pathologically (not traumatically) into a vein, is so great a rarity in surgical practice that it can well be relegated to the domain of pure pathology. It is practically only observed in the

thorax as a result of pathological conditions beginning on the arterial side (aortic aneurism opening into the vena cava, etc)

IV *Personal Experiences with the Suture of Arteriovenous Aneurisms*—In a personal experience of over 204 surgical interventions upon the large blood-vessels, I find the record of 24 cases of arteriovenous injuries of various types. In this group I have utilized the principle of endo-aneurismorrhaphy in 12, *viz*, common carotid, 1, external iliac, 1, the common and superficial femoral, 8, the peroneal vessels, 1, the subclavian, 1. All of these have made good recoveries, except the carotid aneurism, in which death occurred on the eighth day after the operation from coronary disease and pulmonary clot, and, in the iliac aneurism, in which death occurred from mesenteric thrombosis and gangrene of the bowel caused by prolonged compression of a loop of bowel by a powerful Doyen retractor which had been used in an extensive subperitoneal dissection to expose the iliac vessels. In neither case, as shown by autopsy, was the technic of the operation, as far as the vessels were concerned, responsible for the fatal termination, as the condition of the wound was found to be faultless. In the subclavian case, operated on September 3, 1900 (a young white farmer, aged twenty-four years), the artery, which had been perforated with a bullet in the second division, immediately behind the anterior scalene, had to be ligated on each side of the muscle, but the vein, which was surprisingly small, was sutured. The patient recovered but lost parts of his hand from arterial ischemia and necrosis. In this case the operation was performed only two weeks after the injury and illustrates the importance of the time element in developing the collateral circulation.*

Lateral Angiorrhaphy in Arteriovenous Hematoma—In another case a man aged twenty-six years, operated at the Touro Infirmary on May 3, 1907, suffered a gunshot wound involving the femoral vessels in Hunter's canal and was operated about six weeks after the injury by separate lateral suture of each one of the orifices, leaving the lumen of each vessel pervious. The patient made an excellent recovery, with perfect functional result to the limb, notwithstanding his deplorable condition from many wounds, including multiple fractures of the lower jaw, which he had received in quelling a negro riot at Liberty, Miss. This procedure represents probably the oldest and undoubtedly the best known of the conservative operations that have been applied for the cure of arteriovenous aneurisms, and is an ideal method when it can be carried out. The experience of the present war has added a large number of such cases to the early list of the pioneers—Z von Manteuffel (1895), femoral vessels, Cammaggio (1898), femoral vessels, Gérard Marchant (1898), brachial vessels, Peugniez (1900), brachial vessels, Matas (1900), sub-

*This case is fully reported by the author in a paper on "Traumatic Arteriovenous Aneurisms of the Subclavian Vessels" in the Transactions of the American Surgical Association, 1901, and in the Jnl of the Am Med Ass'n, Jan 11, 1902

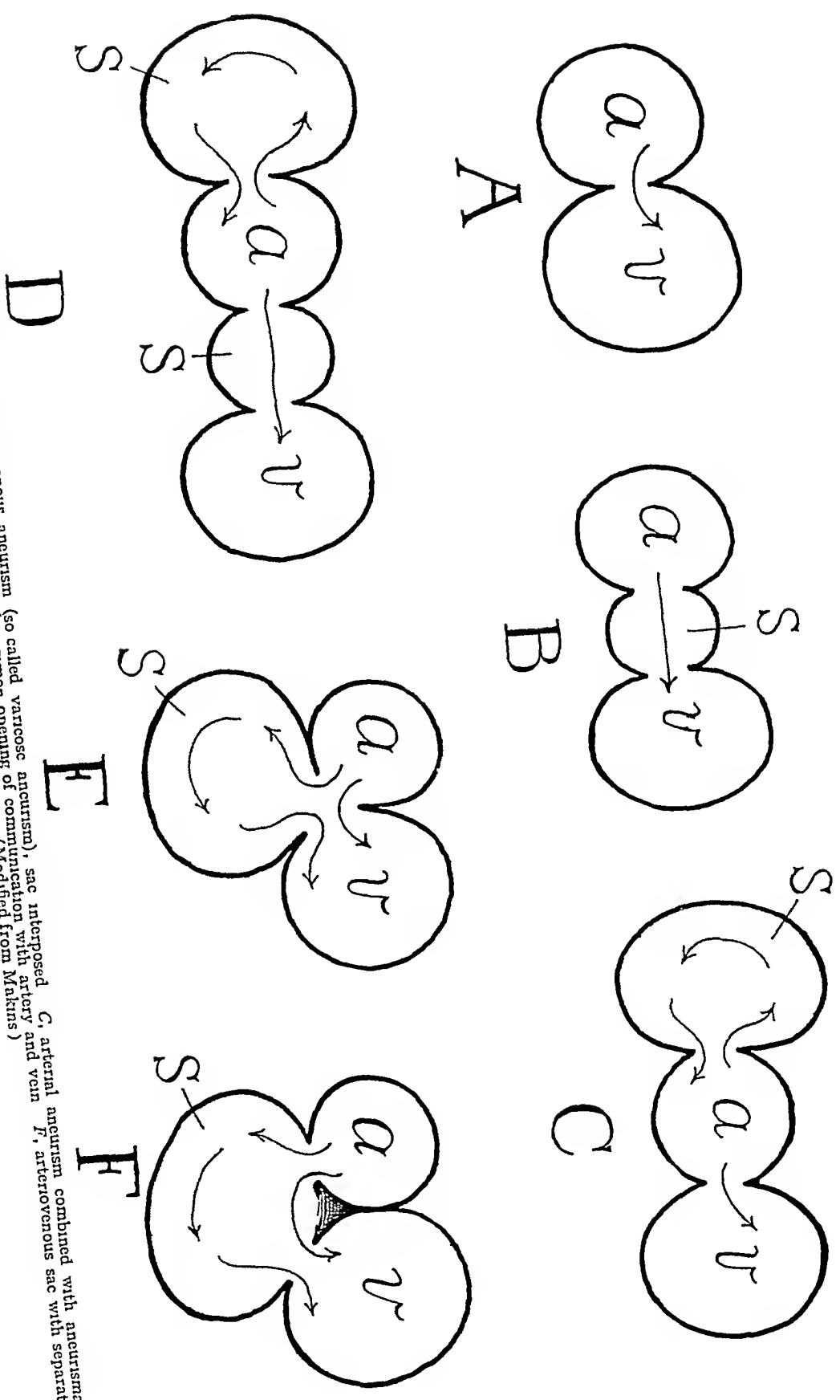


Fig 1—A, simple aneurysmal varix B arteriovenous aneurysm (so called varicose aneurysm), sac interposed C, arterial aneurysm combined with aneurysmal varix D, arterial and arteriovenous sac E, arteriovenous sac with common opening of communication with artery and vein (Modified from Makins) F, arteriovenous sac with separate openings of communication with artery and vein

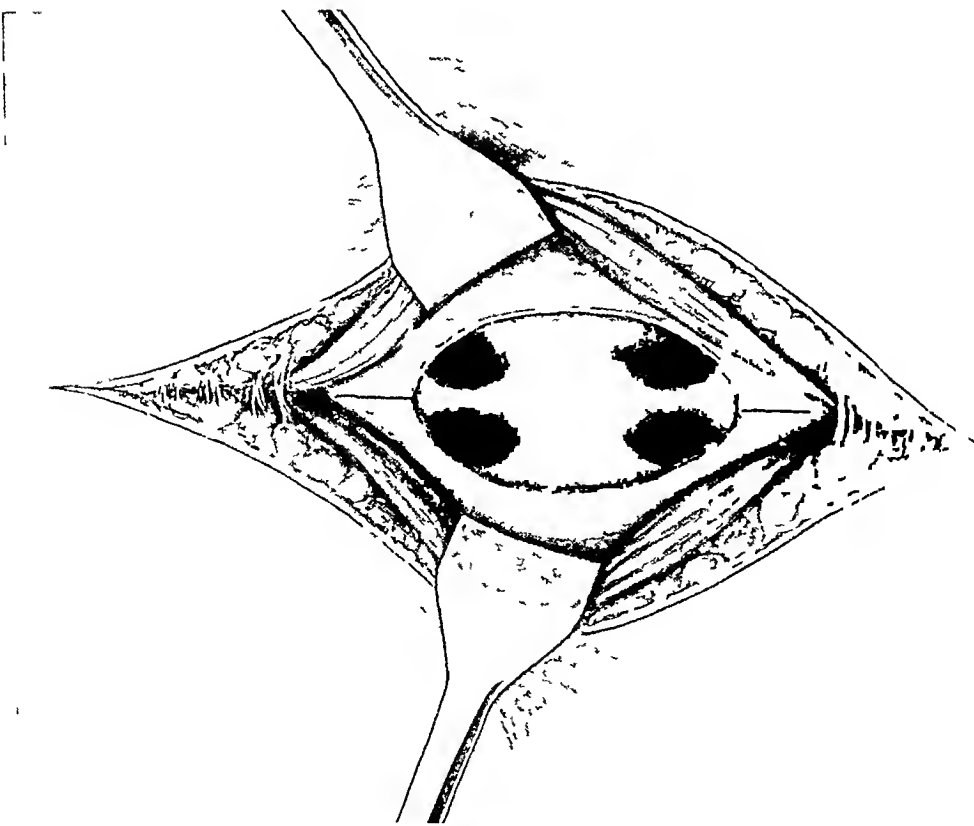


FIG 2.—Case of Walter L. Traumatic arteriovenous aneurysm (so called varicose aneurysm) with the communicating sac in front of the common femoral vessels (stab wound) Obliterative endo aneurysmorrhaphy by Doctor Matas March 8 1912. Vessels not completely divided and held by connecting bridge of the posterior wall which blends with the sac and is entirely covered by a smooth endothelial lining. The ridge in the centre indicates the remains of the vessel walls and septum

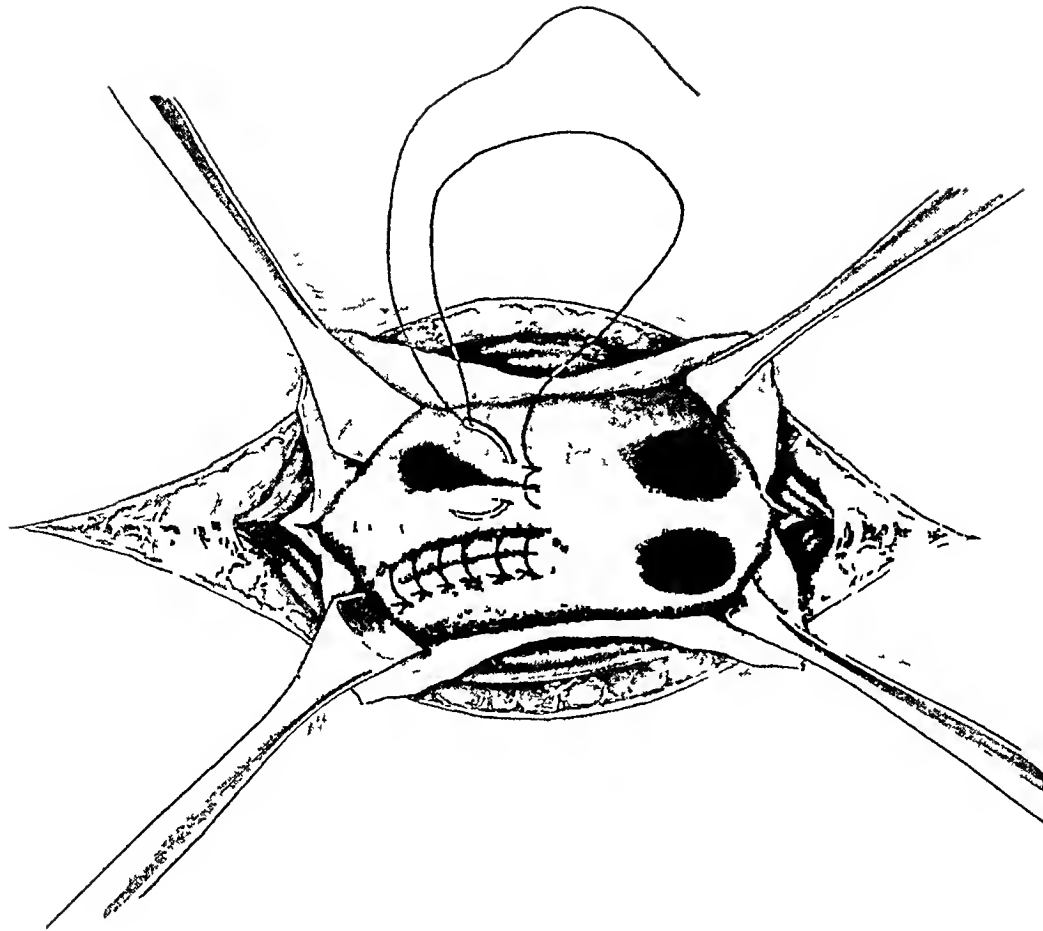


FIG 3.—Case of Walter E. Arteriovenous aneurysm (so called varicose aneurysm) sac in front of femoral vessels. First step obliteration of the orifices by separate suture. The interrupted suture is shown closing the upper orifice to the left and the beginning of a continued suture at the right, as a rule a continued suture is preferable as it secures more perfect sealing of the orifices

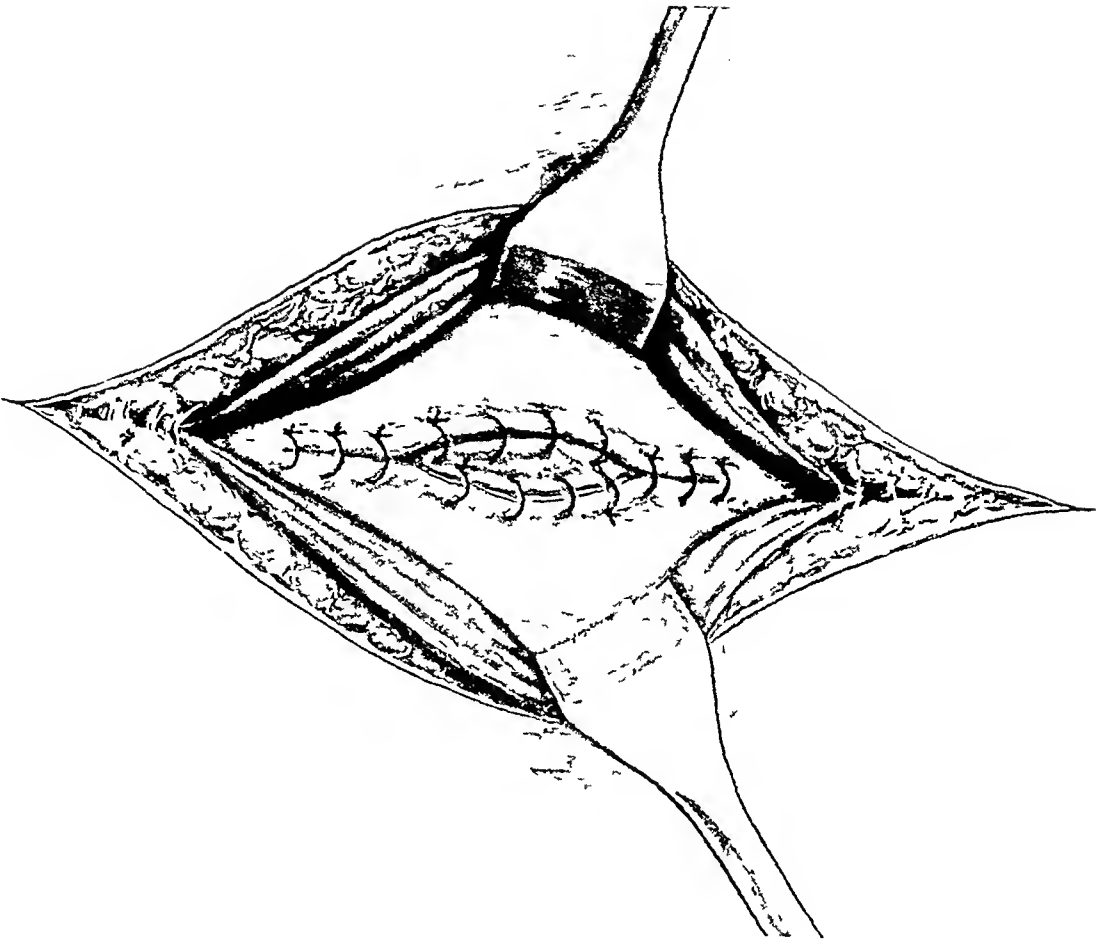


FIG 4.—Case of Walter E. Arteriovenous aneurism, sac in front of the vessels. Second step, obliteration of the false aneurysmal sac by suturing the roof of the sac to the floor without over-tension, to protect the primary orificial sutures leaving a small area in the centre to be covered by the muscular aponeurotic layers as an additional protection. (See Fig 5.)

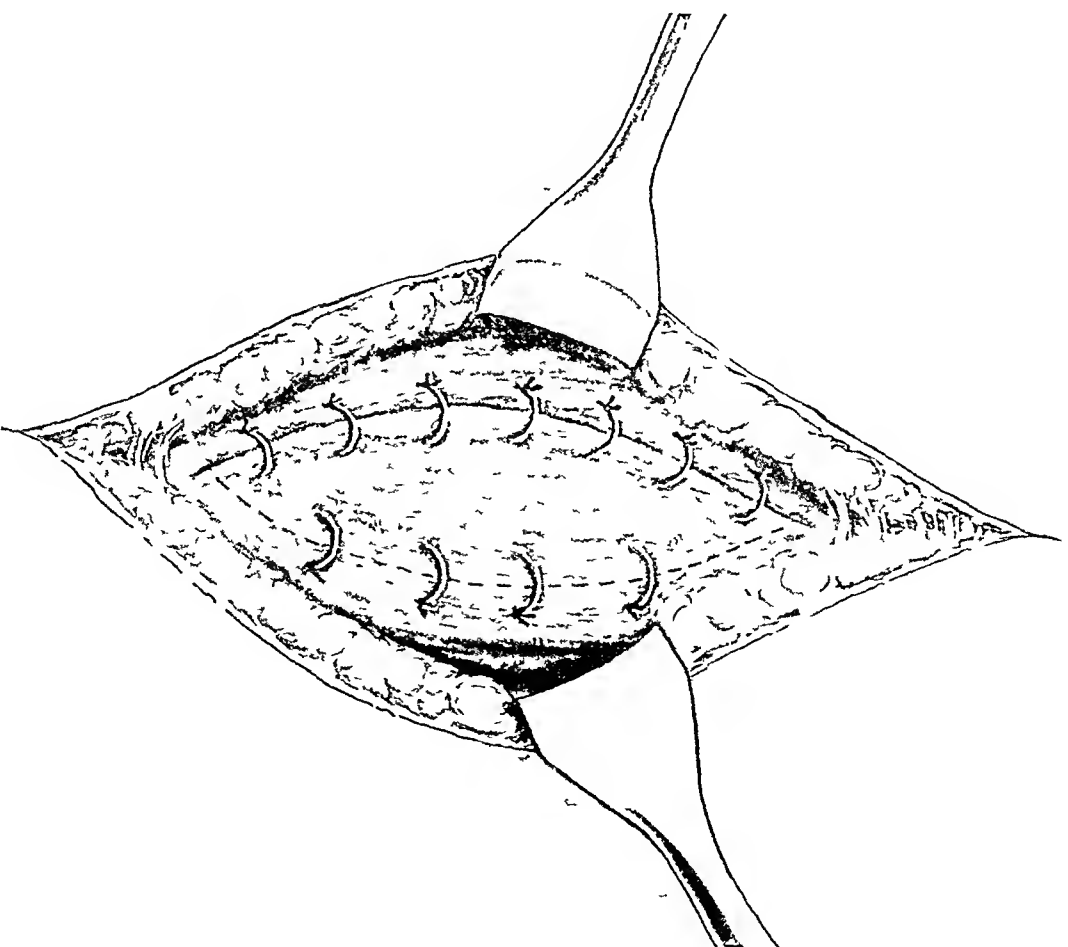
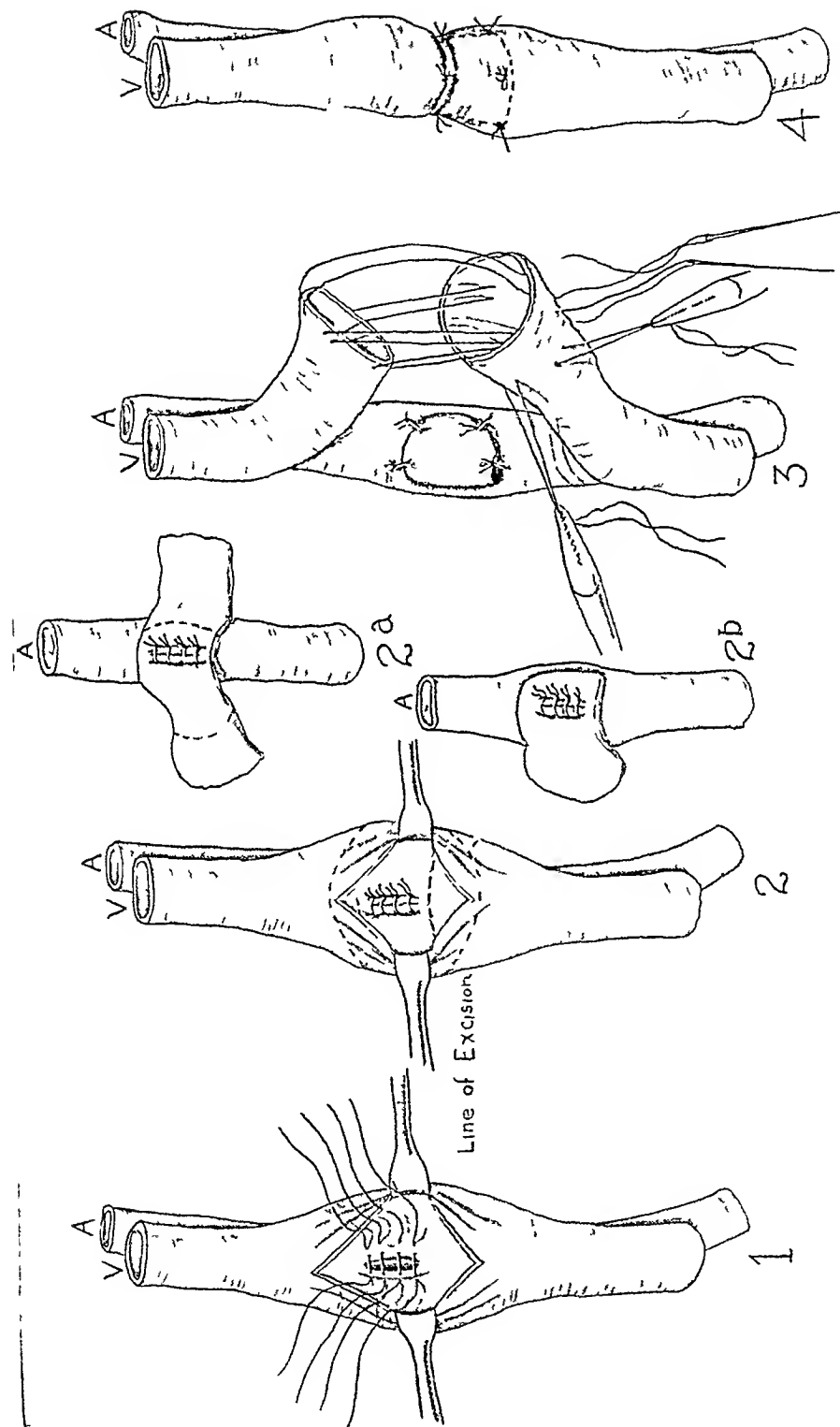


FIG 5.—Case of Walter E. Arteriovenous aneurism. Third step, protecting second line of suture by overlapping musculo aponeurotic planes as in a hernioplasty. The suture of the skin and fat follows as the last step in the operation.



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FIG 6 —One of the methods of closing an arteriovenous fistula (aneurismal varix) by the transvenous route (Matas Bickham procedure), modified by Dr J Chalmers Da Costa (Philadelphia Pa.) See opposite page for explanatory note

The diagrams (drawn from description) shown in Fig 6 illustrate the procedure successfully adopted by Dr J C Da Costa in the treatment of an aneurismal varix of the popliteal vessels (ANNALS OF SURGERY, vol 1v, 1912, pp 592-597)

1 Longitudinal incision of the vein Exposure and suture of the opening into the artery from within the veins

2 The fistulous opening closed, the knots tied, dotted line of incision indicated to show extent of the circular resection of the vein

2a Flap of vein remaining attached to artery and sutured openings, lines indicating the extent of the paring of the venous flap

2b The venous flap reduced by paring remains adherent to the arterial wall with the movable flap ready to be turned over as a hinged cover to reinforce and protect the line of arteriovenous suture

3 The venous flap is shown folded over the line of suture where it is held by a few interrupted sutures The resected and dilated vein is shown in the act of invagination, with the transfixion sutures *in situ*, ready to telescope the proximal into the distal end As a rule, the distal end should be invaginated into the proximal (cardiac) end in accordance with the direction of the venous current to diminish the friction of the blood stream against the cut edges—this should favor better apposition of the venous walls and also diminish the extent of the protecting parietal thrombus It is also the rule of practice, at the present time, to unite the venous segments by the continued Carrel suture of the margins with confrontation of the endothelial surfaces, rather than by invagination by the Murphy method, which is now obsolete

4 The venous anastomosis completed and the continuity of both vessels (artery and vein) restored with complete closure of the fistula

In this procedure Da Costa found it necessary to modify the original Matas-Bickham procedure by cutting out circular section of the vein and utilizing this as a flap to cover and reinforce the line of arteriovenous suture, as shown in Bickham's diagrams (ANNALS OF SURGERY, May, 1904) The patch of the venous wall through which the fistula has been closed is alone excised and allowed to remain *in situ*, attached to the artery, and the oval gap remaining in the vein is closed from without by a continued suture The longitudinal incision through which the fistula is closed is also sutured, and in this way the lumen of the vein is completely restored Usually the vein is abnormally dilated and a plastic patch can be excised from its walls and the remaining gap sutured without constricting it unduly In Da Costa's case the calibre of the vein had been so considerably reduced by the transvenous suture that he deemed it necessary to do a circular resection, as shown in the diagram, and the result was excellent

[I have taken the liberty to substitute the present drawings for those which accompany Doctor Da Costa's original paper, believing that these will make the details of the procedure more intelligible—R M]

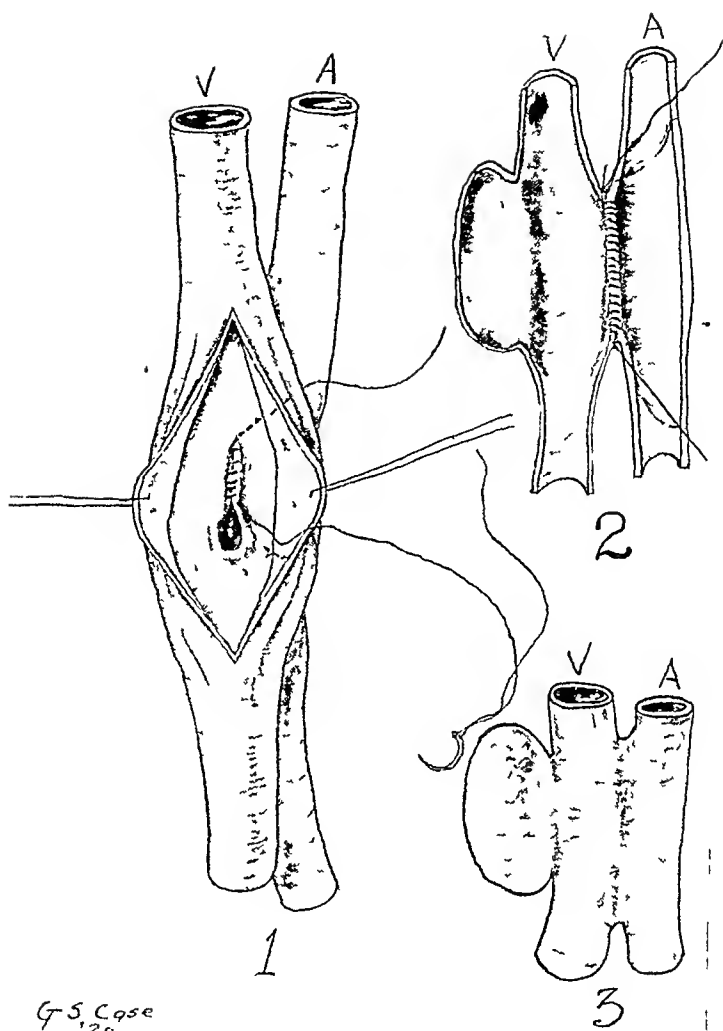


FIG 7—Closure of an arteriovenous fistula (aneurismal varix of the popliteal vessels) by the transvenous route (Matas Bickham operation) with preservation of both vessels leaving no knots in the lumen of the vein. These diagrams illustrate a recent successful clinical application of this method by Dr William Pearson Dublin (*British Med Jour*, June 14 1919). 1 longitudinal incision of the vein with exposure of the arteriovenous orifice on the venous side. The arteriovenous stoma is being closed by a fine continued suture. No knot appears in the interior of the vessels. In practice the sutures are not exposed in the lumen of either vessel as much as figured. When the suture is drawn taut the thread line practically disappears with the edges of the orifice. The needle is introduced from the outside. 2 shows the continued suture closing the arteriovenous fistula leaving no knots in the lumen as viewed in cross section. 3 diagram of the varix showing the saccular dilatation of the vein opposite the fistula which was observed in Pearson's case. The sac was cut off and the fistula closed through the opening left by the excision. This method of endoaneurismal suture without knots in the lumen is even better shown in Bickham's paper (*ANNALS OF SURGERY* May 1904). [These drawings have been copied from Dr Pearson's original illustrations with modifications—R. M.]



FIG 8 —Case of John G —jugulo carotid aneurism

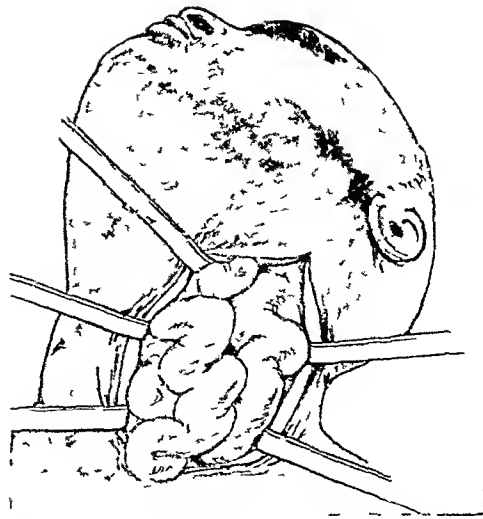


FIG 9 —Case of John G —jugulo carotid aneurism Preliminary exposure of enormously enlarged plexus of superficial pulsating cervical veins

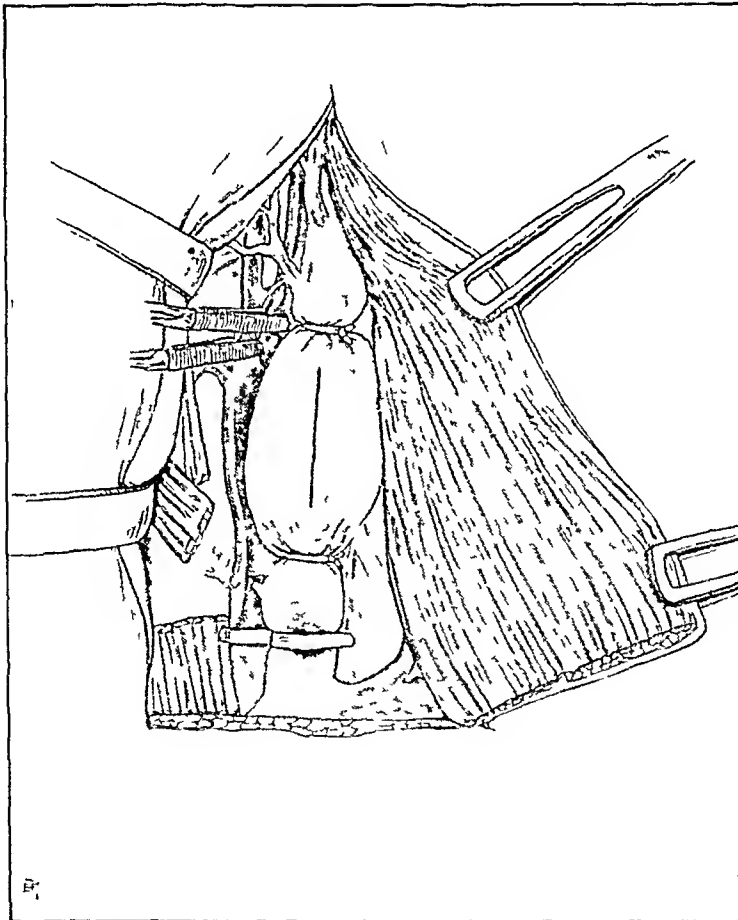


FIG 10 —Case of John G (jugulo-carotid aneurism), shows the dilated jugular in relation with the carotid. With flat aluminum band applied to jugular and to the common carotid, also two Hoepfner clamps applied prophylactically on the internal and external carotids separately, two catgut ligatures on the jugular above and below the arteriovenous fistula, line of incision into the jugular to expose the arteriovenous communication

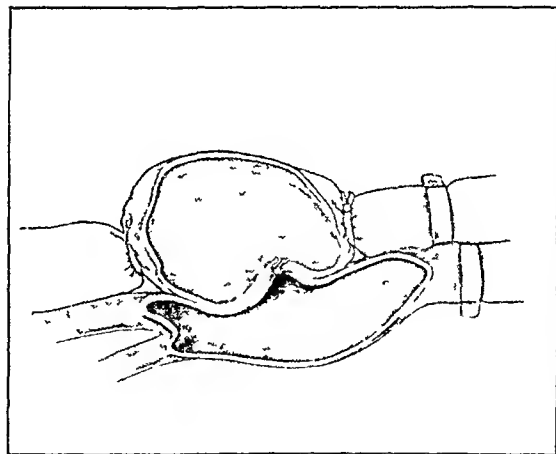


FIG. 11.—Diagrammatic representation of the arteriovenous communication between the carotid vessels in the case of John G. (jugulo carotid aneurism)

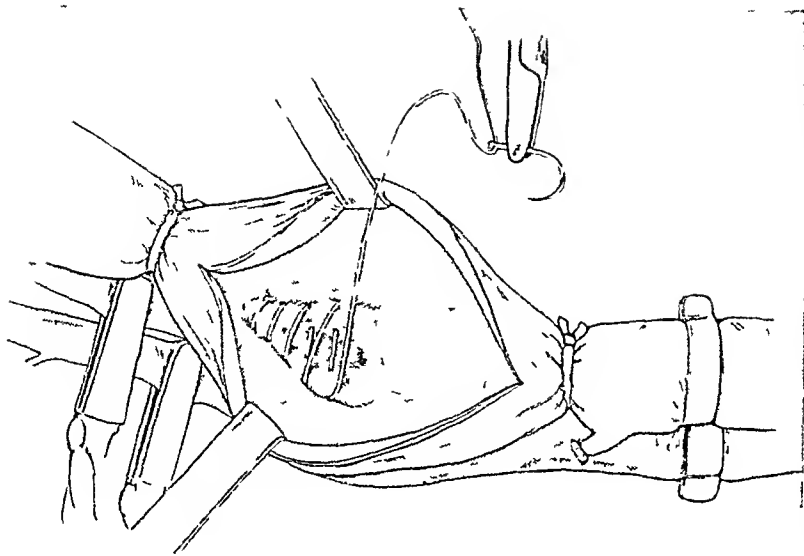


FIG. 12.—Interior of the sac exposed by opening the anterior venous wall. The method of obtaining hemostatic control is shown. The single orifice of communication with thickened edges is closed by continued suture

clavian vessels, and to those of other civilian and military surgeons who had availed themselves of the progress in vascular suture long before the late war

The Obliterative Suture in Arteriovenous Aneurism of the Varicose Type with Communicating Pseudo-sac—Another case, operated on March 9, 1912, was that of Walter E., a youth of eighteen years, from Wesson, Miss., who had been accidentally stabbed when twelve years old, with a long pocket knife, in the upper femoral region. He had developed an arteriovenous aneurism which involved the common femoral vessels at the apex of Scarpa's triangle, close to the origin of the profunda. In view of the long duration of the aneurism and possible necessity of doing an obliterative operation, the boy was kept under careful observation for two weeks before the operation. During this time he was fed abundantly and given digitalis systematically, in the hope of increasing his blood-pressure which was scarcely ever over $\frac{110}{65}$. Frequent tests were made of his collateral circulation, which showed that the living color returned to the limb after Esmarch ischemia, while the common femoral was compressed. The living color returned in about five minutes, but just before the operation the time had shortened to three minutes. Feeling that a good collateral circulation had been established, I undertook the operation, believing that if it became necessary an obliteration could be performed without risk to the limb. The operation was performed under ether, at the Touro Infirmary, on March 9, 1912. The incision, directly into the sac, revealed a large well-lined cavity which was at first taken to be the dilated femoral vein, but which was subsequently interpreted as a pseudo-sac well lined with endothelium which opened directly into a lesser pocket of oval shape, measuring about two inches in diameter (Figs 2, 3, 4, and 5). At the bottom of this could be seen four separate orifices, each large enough to admit the tip of the little finger and grouped into a quadrilateral, the two openings on the inner side corresponding to the distal and proximal orifices of the femoral vein and the two outer to those of the artery. A ridge or linear induration indicated the original septum of the sheath which separated the arterial from the venous compartment, but the edges of the orifices were continuous and blended with the septum and with the smooth glistening endothelial surface that lined the interior of the sac. Each one of these orifices was now sutured separately with fine paraffined linen, leaving them completely sealed and obliterated. Then all communications leading from the large vessels to the sac were closed. The sac, which was very densely incrustated all over its walls with calcareous deposits in plaques, was only cleared of these incrustations by prolonged scrubbing with saline solution and gauze sponges. In the main cavity, which formed the bulk of the aneurism (size of a small apple), a mass of phleboliths was found in the midst of the red clot. After the toilet of the sac had been

completed, this was obliterated partially by bringing the sac walls in apposition with continued rows of fine chromic gut sutures, in the manner shown in Figs 4 and 5

The blood-pressure before the operation (9 40 A M) was 110 S , during the operation it rose to 120 S , and at the close of the operation (10 25 A M) it fell again to 110 S . At the close of the operation the Esmarch constrictor, which had been applied high up in the groin, was removed and was followed, in less than one minute, by a return of a good living color throughout the extremity to the tip of the toes . At 10 35 A M the dorsalis pedis and posterior tibial could be felt beating distinctly in the foot . Evidently the preliminary tests of the collateral circulation had told the truth, and the results confirmed our confidence in their value, and justified the obliterative operation which we had adopted

The records show that the wound healed *per primam* . It was inspected on the fourth day . An ulcer which had existed in the leg as a consequence of the varicosities healed rapidly, and the boy was discharged and returned to his home on March 29, nineteen days after the operation, with his ulcer healed, a notable reduction in the varicosities, and perfect functional use of the limb

Since the day of his discharge I have seen the boy repeatedly, and in my last examination, one year ago, there was no trace of the aneurism, and only a linear scar indicated the site of the operation . The varicosities along the saphenous tract had subsided, the ulcer had remained healed, and even the pigmentation which had darkened his leg had paled . He was working on a farm and doing hard labor as a field hand

This case illustrates not only the simplicity and safety of the technic of the intrasaccular suture in its *obliterative* phases, but its successful application to a type of varicose aneurisms which is not infrequent and could be made quite formidable if attacked by followers of the methods of either one of the extreme and divergent schools of vascular surgery—the ultra-conservatives, represented on the one hand by the German followers of Lexer (in the early stages of the late war), who believe it their duty to do the so-called “ideale” operation in every case in which it was feasible and who, taking this case as an example, would have systematically extirpated the sac, dissecting out the vessels from their bed and attempted to do an end suture of both vessels,⁵ and, on the other hand,

⁵ Early in the war, Bier, Kuttner and other leading operators soon abandoned the extirpation of the sac in mature aneurisms as superfluous and unnecessarily traumatizing, and, in addition, dangerous to the collaterals—and thus got rid of one of the most objectionable features of the Lexer procedure . In lateral wounds, amounting to about 50 per cent of the cases, they simply did an intrasaccular suture of the orifice of communication, precisely as I do a restorative endo-aneurismorrhaphy . In the complete sections of the vessels, when the vessels opened into the sac by separate orifices, they did a *transsaccular* dissection of the divided vessel with careful and minute preservation of the collateral branches, and, after mobilizing the

the ultra-radicals, represented by the French school of surgeons who, following the lead of Delbet, extirpate the sac together with its vascular contents and then ligate the four stumps by the quadruple ligature

Between these stand the intrasaccular ligaturists of the British and Japanese schools, who do far less damage to the perivascular tissues, but who, none the less, give themselves unnecessary worry and complicate their technic by dissecting out the main vessels and their collateral branches in order to close them by the quadruple ligature

It is possible that by any one of these methods this aneurism would have been cured and the limb saved, because in this case it had been clearly demonstrated that the collateral circulation had been established and that restorative or reconstructive procedures were unnecessary. But why undertake a laborious and, at best, the uncertain circular angiorrhaphy, as in the so-called "ideale" operation, or subject the patient to the unnecessary trauma of an extirpation of the sac with its waste of good vascular material? Or, again, why insist upon the extrasaccular dissection by the quadruple ligature, when the simple obliteration of the orifices in the sac can be so often easily accomplished with the suture and with so much economy to the blood-vessels? Why not endeavor to attain the objective aimed at by the elementary and safe technic of the endo-aneurismal suture?

I could easily add to the testimony offered by the preceding case by a number of clinical experiences which prove the simplicity and reliability of the endo-aneurismal suture in the many phases of *varicose* aneurism in which the *obliterative* principle is indicated. Apart from my own experiences I could quote a number of confirmatory reports from the practice of my associates and other local surgeons (Doctors Gessner, Parham, Maes, Danna, and others) who have adopted the endo-aneurismal suture and successfully applied it in the treatment of arteriovenous lesions.

But I must proceed with the treatment of the most familiar type of arteriovenous injury, the *aneurismal varix* or fistula, which has furnished me with the largest and most varied experience in nine cases, in all of which I have applied the principle of endo-aneurismal suture in its *restorative*

vessels, united the divided segments by a circular suture, leaving the sac intact. Kuttner has gone much further than his contemporaries in utilizing attached sac flaps to patch extensive wounds of the arteries which were too large to allow of lateral arteriorrhaphy, thus avoiding whenever possible the necessity for a circular suture. In this way he has also utilized the principle of sac repair and arterial reconstruction far beyond the original scope contemplated by the writer in his reconstructive endo-aneurismorrhaphy. As a rule, in such extensive perforations I would apply the obliterative intrasaccular suture after testing the efficiency of the collateral circulation by previous tests.

In the course of the war the majority of German surgeons have virtually abandoned the method of grafting a venous segment to bridge the gap between the divided sections of the artery. They have found that this procedure did not justify by its results the time and labor expended in its performance. At any rate, it is largely recognized as a failure from the point of view of the practice of military surgery.

phases, with a success that could scarcely have been obtained by any one of the conservative or radical procedures in vogue

In order to approach this subject more intelligently, a brief reference to the historical evolution of the special modification of the endo-aneurismal method as adapted to the peculiarities of *aneurismal varices* is necessary

V *Endo-aneurismal Suture by the Transvenous Route*—In the ANNALS OF SURGERY for February, 1903, I published my first systematic account of the endo-aneurismal method of suture which I had first applied to a brachial aneurism on March 30, 1888 (*Medical News*, Philadelphia, October 27, 1888)

My paper dealt with arterial aneurisms and not with arteriovenous lesions, though the indications for the suture in these cases were obvious. This gap in the technic, however, was quickly filled by my friend and former associate, Dr W S Bickham, of New York, who in an excellent paper published in the ANNALS OF SURGERY for May, 1904, suggested and elaborated a most ingenious technic for the application of the intrasaccular suture to the various lesions grouped together under the name of arteriovenous aneurisms

The methods suggested and so clearly illustrated by Doctor Bickham in 1904 will be found more systematically described in his excellent "Text-book of Operative Surgery" (Third Edition, Saunders, 1908), under the heading of "Operations for the Radical Cure of Arteriovenous Aneurisms with Preservation of the Circulation in the Artery and Vein. The Matas-Bickham Operation"

Bickham's foresight and planning of this technic which was based upon the theoretical possibilities offered by the most familiar types of arteriovenous aneurisms are, indeed, most remarkable and praiseworthy

The first clinical application of one of Bickham's suggestions, *viz*, to attack the problem of closing the fistula in aneurismal varix by the transvenous route, was first demonstrated clinically by my friend and associate, Dr H B Gessner (*N O Medical and Surgical Journal*, vol lx, 1907-8, pp 553-556), in the case of a colored laborer, aged twenty-two years, who had sustained a gunshot injury (multiple small shot) in the abdomen and right thigh. The injury had been inflicted eleven years previously and involved the femoral vessels in Hunter's canal. The injury had caused comparatively little disturbance. The operation was performed on May 30, 1908. The sac itself was small and, notwithstanding the long duration of the injury, there were none of the varicosities or trophic changes in the skin of the lower extremity which characterize the progressive types of varix aneurismaticus. The thrill and murmur caused the patient anxiety and this was the chief reason for the intervention. In this case the sac was formed by ampullar dilatation of one of the venæ comites, the other being intact. Three arteriovenous fistulæ caused by small shot were discovered in the interior of the venous sac when this was opened. They were all closed by separate intrasaccular

TREATMENT OF ARTERIOVENOUS ANEURISMS

sutures and the artery left undisturbed. The sac itself was folded and obliterated by suture.

The endo-aneurismal suture by the transvenous route was also utilized for the cure of aneurismal varix by Dr J Chalmers Da Costa of Philadelphia (ANNALS OF SURGERY, vol. 14, pp. 593-597, 1912). The operation was performed on October 22, 1910.

The patient, a young woman, aged twenty-nine years, had been shot accidentally three months before the operation in the left popliteal space, with a No. 22 calibre bullet. Under ether, and after preliminary hæmostasis with Esmarch constrictor, the popliteal vessels were exposed and a longitudinal incision was made on the outer side of the vein. The fistulous opening which connected the two vessels was readily exposed and closed from *within* the vein with a No. 0 iodized catgut. On tying the sutures it was found that so much of the venous wall had been drawn in by the stitches that the calibre of the vein was greatly reduced. The vein was, therefore, divided transversely on each side of the point of fusion to the artery and a flap was cut out of the excluded venous segment and superimposed over the suture line in the artery and sewed to the artery by interrupted catgut sutures. Thus a flap of the vein was used to strengthen the line of suture at that point. The flap was about one inch in length. The two ends of the vein were then brought together by invaginating the upper (narrower) end into the larger (lower) end and fixed with four transfixion sutures, the line of junction being reinforced by a few catgut sutures passed through the external coat. The tourniquets were now removed and the blood jumped into both vessels, flowing through their respective channels, the artery pulsating vigorously and without a bit of leakage. The patient made an uneventful recovery. In a month she walked naturally (Fig. 6).

This very interesting case shows how the technic of a transvenous arteriorrhaphy or endo-aneurismorrhaphy can be ingeniously modified to meet the requirements of a conservative practice without affecting the fundamental principle involved in the procedure.

Another interesting illustration of the successful application of the transvenous method of closing an arteriovenous fistula by suture with the preservation of both vessels is furnished in the report of an aneurismal varix of the popliteal vessels, operated upon by Dr William Pearson, surgeon to the Adelaide Hospital, Dublin, under the title of "Transvenous Aneurysmorrhaphy" (*British Medical Journal*, June 14, 1910, pp. 736-737).

The operation was performed on January 15, 1917, on a soldier aged twenty-two years, who had been wounded with a rifle bullet on October 11, 1915 (nearly seventeen months before the operation). The popliteal vessels were exposed in the upper part of their course, where the artery and the vein were firmly adherent to one another without any intervening sac. Here the vein was greatly dilated and

the artery below was considerably smaller than usual. When freeing the side of the vein from its connection with the artery a saccular venous aneurism was exposed (see Fig 7) and was removed, disclosing the arteriovenous stoma through the lumen of the vein. It was of an elongated elliptical form, one-half inch in length, and lying in the long axis of the vessel. The opening in the vein was enlarged very slightly upwards and downwards, and through it the aneurismal opening was sutured with a fine silk sterilized in liquid paraffin. The vein was then closed by continued suture. On removal of the tourniquet there was no bleeding, and the circulation through the vessels seemed perfect. The operation was completed by suture of the fascial tissue and the skin.

After the operation good pulsation was felt in the dorsalis pedis and posterior tibial arteries. On the following day there was no trace of œdema in the limb, the color was normal and the dilatation of the superficial veins had disappeared. Healing was uneventful, the circulation remained good, and the patient was allowed to walk four weeks after operation. He was kept under observation for two months and then discharged to light duty, the circulation being normal.

This case presents several unusual features apart from the technic employed to cure the aneurism—which can only be referred to in a cursory way, as the operative phase of the case is what concerns us in this paper. The fact that a distinct aneurismal sac formed opposite the fistula at the expense of the venous wall is rare, a general dilatation of the vein, often attaining enormous proportions, is common in old aneurismal varices, but a well-defined venous sac springing in an isolated fashion, as in this case, is not so frequent. When it exists, it lends, for obvious reasons, additional advantages to the transvenous method of suturing the orifice of communication. The fact, also, that in this case no signs of arterial varix developed until massage was applied to the limb, three months after the injury, is also instructive and justifies the opinion previously expressed by Pearson, that massage has proved an exciting cause of the rapid development of previously latent traumatic aneurisms in certain gunshot wounds of the blood-vessels.

The care taken by the author to avoid injury to the endothelium of the vein while exploring its interior as a preliminary to the transvenous suture by irrigating with warm saline instead of wiping the interior of the vein with gauze to clear the fistulous origin, and spraying with liquid vaseline, shows his appreciation of the dangers of thrombosis from rough swabbing of the endothelium.

But the method of introducing the suture to close the arteriovenous communication is most important. The needle is first passed through a small portion of the fibrous tissue which binds the vessels together at one end of the communication, on its external aspect (that is, entirely outside of the vessels and between the two), and does not penetrate the intima of either—it thus resembles the commencement of the outer row of sutures in a gastro-jejunostomy. This stitch is immediately tied and the needle is then passed obliquely from without inwards, emerging on the inner surface of the vein, close up to the extremity of the stoma (Fig 7). The extreme edges of this are then brought together by fine

continuous suture through intima and media until the opposite end is reached, when the needle is again passed out from the lumen of the vein obliquely through its wall and the overlying tissue which binds it to the artery, so as to emerge between the two, when it is secured in a similar manner to the other end

Thus it will be seen that there is no knot projecting in the lumen of either vessel, and if the stitches are placed accurately and drawn taut throughout, they do not present in the lumen of either vessel any more than in the case of ordinary through-and-through sutures. The closure of the incision in the vein presents no difficulty, being effected by continued suture which brings the opposed endothelial surfaces in confrontation. The result obtained by Pearson in this case is most gratifying, as it confirms the value of Bickham's excellent suggestion and my own personal experience with the transvenous method of aneurismorrhaphy in the treatment of aneurismal varices.

It is noteworthy that the technic described by Pearson, and which he appears to have worked up independently, is identical in principle and almost in every detail with that described and illustrated by Bickham in the *ANNALS OF SURGERY* for May, 1904, and in his *Operative Surgery*, third edition, 1908, p 136, under the title of the "Matas-Bickham Operation," and also reproduced in my chapter on Vascular Surgery of Arteriovenous Aneurisms, *Keen's Surgery*, vol v, pp 308-909, 1909, where the identical method of passing the obliterative suture from without inwards, leaving no knots in the lumen, is shown in Fig 104.

What is more important is to remember that, while the approach to the arteriovenous communication in aneurismal varices is accomplished by opening the vein, and the closure of the fistula is obtained by the suture of the orifice through the *interior* of the dilated vein, as the essential features of the method advocated by Bickham and myself—the final disposition of the vein will vary according to the anatomical conditions revealed in the course of the operation.

It is evident that the ideal to be aimed at is the preservation of both vessels, especially when dealing with the large trunks at the root of the neck and of the limbs, but when for any technical reason it is difficult or impossible to close the orifice of communication without sacrificing the vein, this should be done unhesitatingly if by this sacrifice the arterial lumen can be preserved, or the closure of the fistula better secured. The examples already given and the reports that follow will show how, in some cases, the vein can be preserved in its integrity after the transvenous suture, and how, in others, it has been found necessary to ligate the vein above and below the anastomosis, or obliterate it by plication or utilize the attached segment to protect the line of suture with a reinforcing patch or flap cut out of the venous wall.

VI The following case illustrates the application of the transvenous method of endo-aneurismorrhaphy to a *varix aneurismaticus* of the jugulo-

carotid vessels, in which the vein was obliterated by plication after the closure of the anastomosis, leaving the external and internal carotid circuit at the bifurcation open. This case shows all the evils that may follow a long-standing arteriovenous fistula as a result of the short circuiting of the carotid stream through the fistula with secondary overstrain and dilatation of the right heart. It was a most trying and forbidding case which I would never have dared to approach by any other procedure.

Arteriovenous Fistula (Gunshot of Fifteen Years' Standing) of the Jugulocarotid Tracts, at the Bifurcation. Obliteration of the Orifice of Communication by Direct Suture Applied by the Transvenous (Transjugular) Route, Leaving an Open Collateral Channel to the Brain via the External and Internal Carotids and the Bifurcation (Fig. 8).—The patient, John G., an intelligent negro barber, aged forty years, consulted me first on April 12, 1912. He had been shot in the neck fifteen years before he applied to me for relief of symptoms caused by an aneurismal varix which, in the course of these years, had led to an enormous dilatation of the jugular and all the tributary veins. The man had been shot in an altercation, with a revolver, at close range, and the bullet (38 calibre) had perforated the internal jugular and the common carotid on a level with the bifurcation. The bullet, as was discovered fifteen years after, had lodged in the back of the neck and could be seen, in the radiograph, behind the articular process of the third cervical vertebra. The hospital record shows that one hour after the injury he developed unmistakable signs of an arteriovenous communication, which persisted and gradually grew worse as time went on. Simultaneously with the bivascular injury the spinal cord had been wounded. From this injury he gradually recovered in the course of five years. Also, as an immediate sequel of this injury, he developed a traumatic meningitis with hyperpyrexia (107.6°), which kept him in a state of unconsciousness and delirium for fifteen days. He recovered slowly, but was finally discharged from the hospital, hemiplegic, with the aneurismal varix in full activity. Apart from the annoying thrill and great noise which he heard roaring in his head, he was fairly comfortable and was able, at the end of five years, to return to his trade as barber. It was not until about one year before his consultation with me that the aneurism, or, at least, the swelling in his neck, grew rapidly, and he began to suffer with dyspnoea and with "choking spells" whenever he made unusual muscular efforts. He then had to give up his work and go to bed. His history also showed that he had been a steady drinker and a syphilitic. He had a large dilated heart and aorta with an aortic obstructive murmur, an irregular pulse, and relatively low blood-pressure. He was a stout man, weighing over 212 pounds, and his neck was disproportionately large from the great turgescence and enormous dilatation and tortuosity of the superficial veins, which pulsated, purred, and thrilled like living things. He had also developed a left-sided

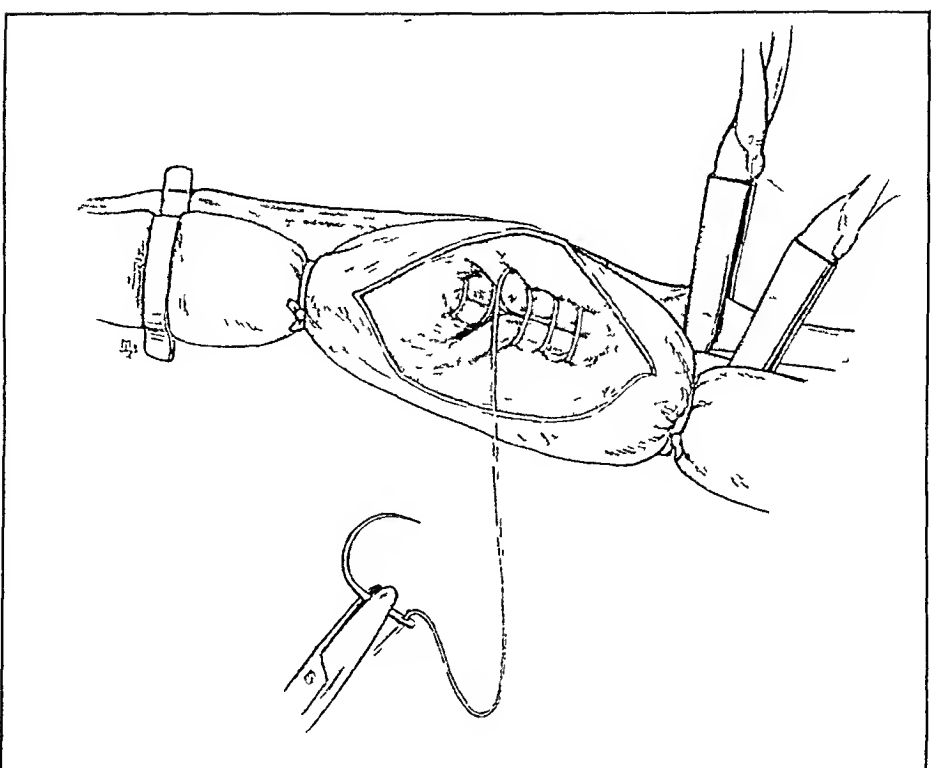


FIG 13—Obliteration of the sac by infolding and suturing the venous walls in superimposed layer after closure of the orifice

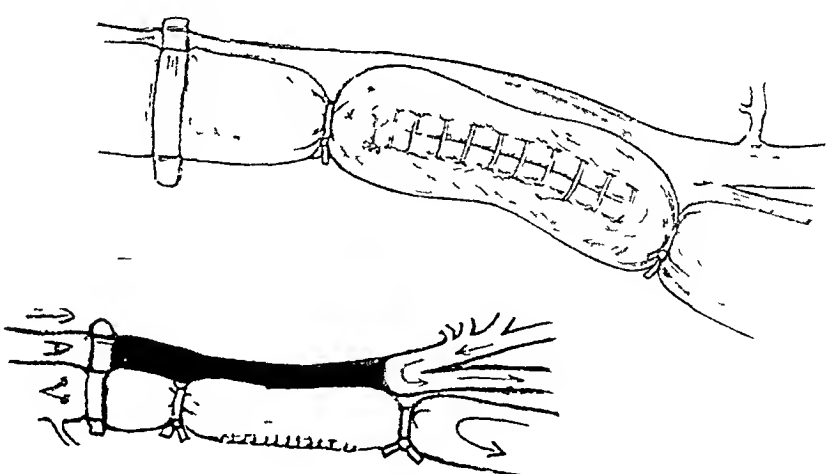


FIG 14—Case of John G.—jugulo carotid aneurism. A shows the fistula closed and the incision into the vein sutured. An additional row of sutures followed thus to completely obliterate the vein by infolding or plication. B shows the final result with the lesser collateral circulation maintained through the external and internal carotid and the bifurcation

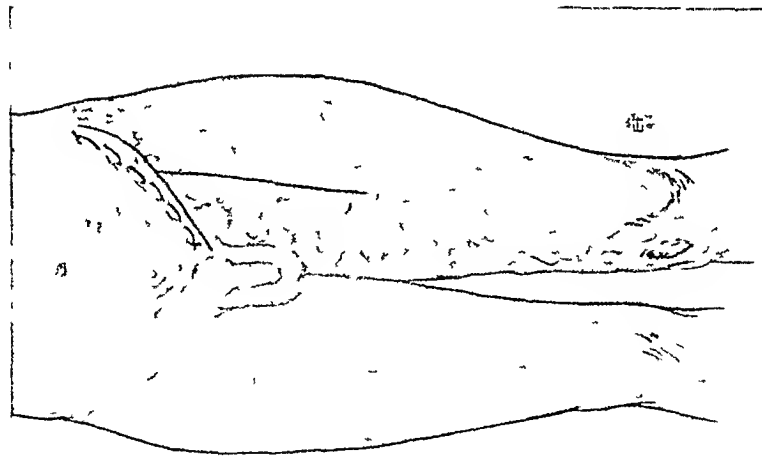


FIG 15—External appearance of the left lower limb showing varicosities and line of incision also line of continued percutaneous suture to control bleeding from superficial abdominal plexus of veins Case of J H H—arterio-venous aneurism of the common femoral vessels

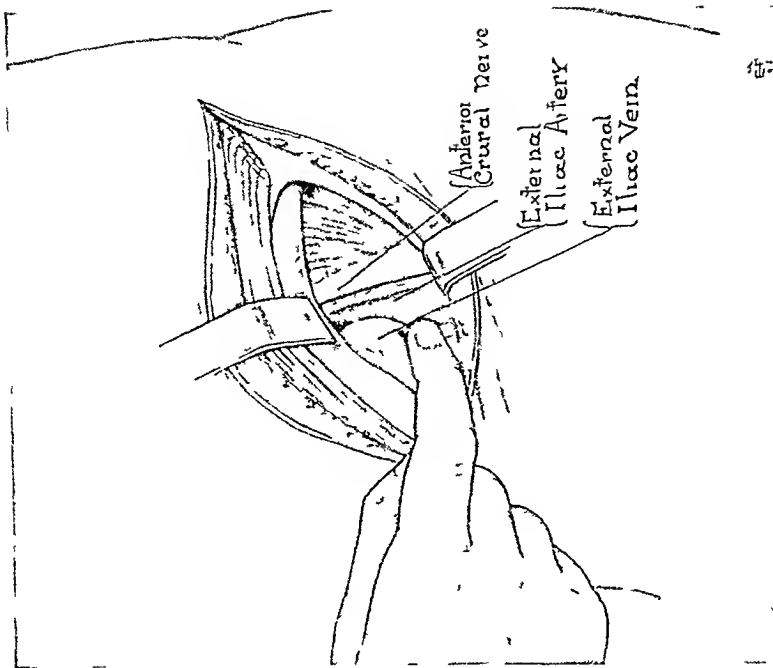


FIG 16—Iliac incision showing relations of external iliac vessels and anterior crural nerve the finger pushing the enormously dilated vein aside Case of J H H—arteriovenous aneurism of common femoral vessels

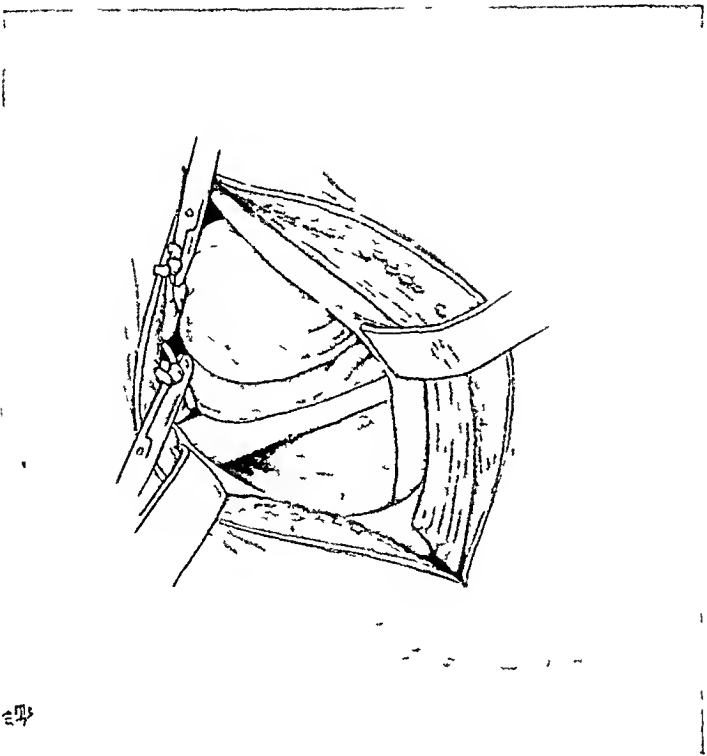


Fig 17—Same dissection showing artery controlled by provisional elastic ligatures

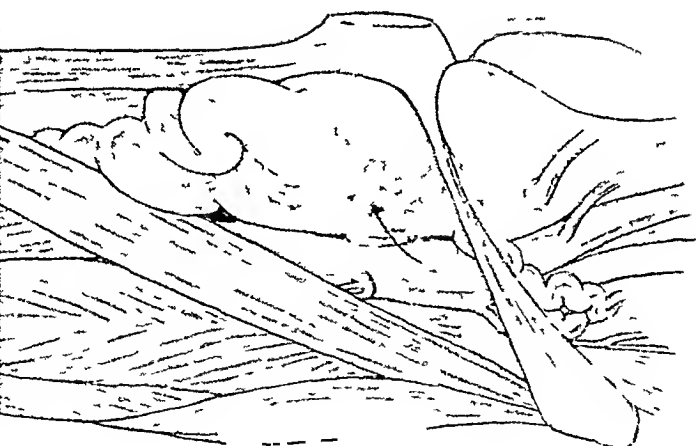


Fig 18—Appearance of dissection above and below Poupart's ligament. Shows seat of the arteriovenous anastomosis and enormous enlargement of the vein

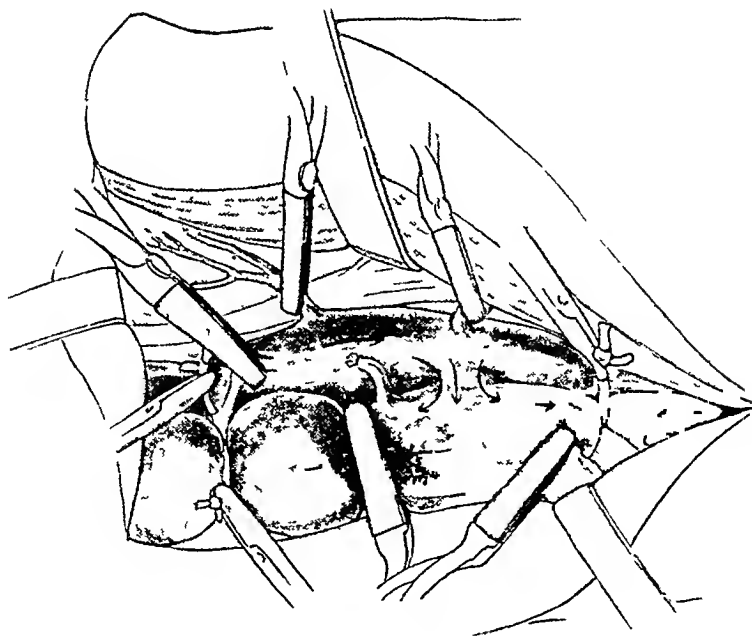


FIG 19 —Deep dissection after division of Poupart's ligament and methods of prophylactic hemostases before attempting the detachment and separate suture of the vessels

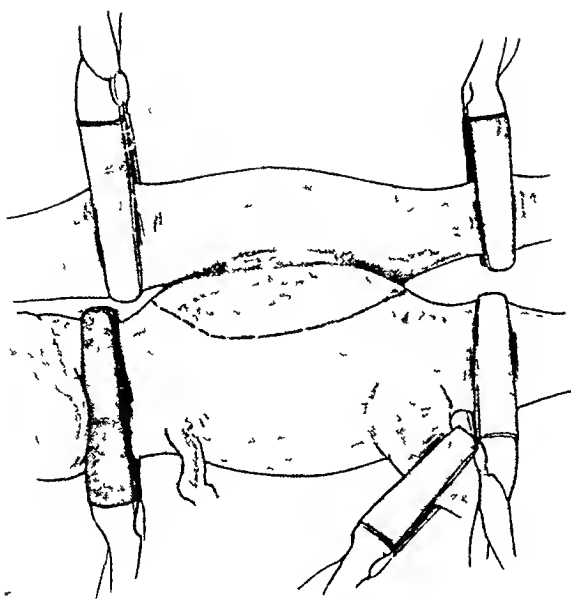
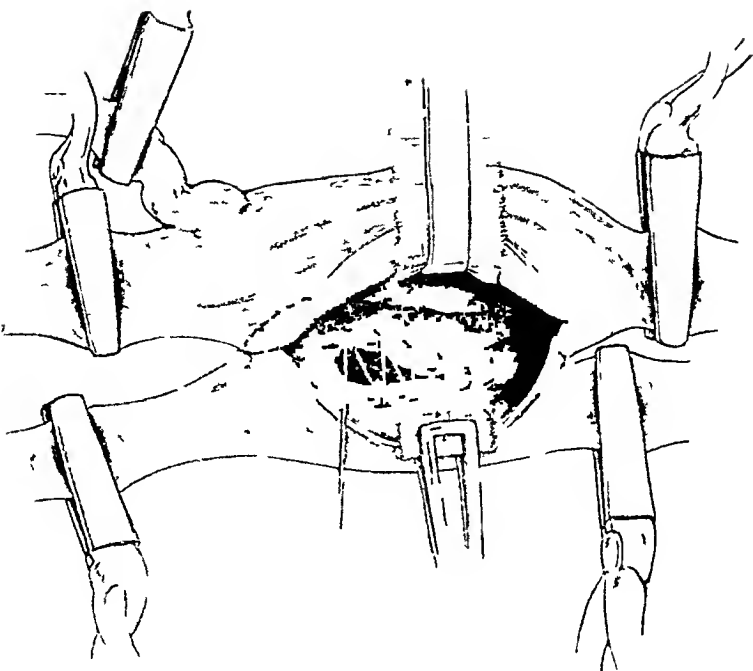


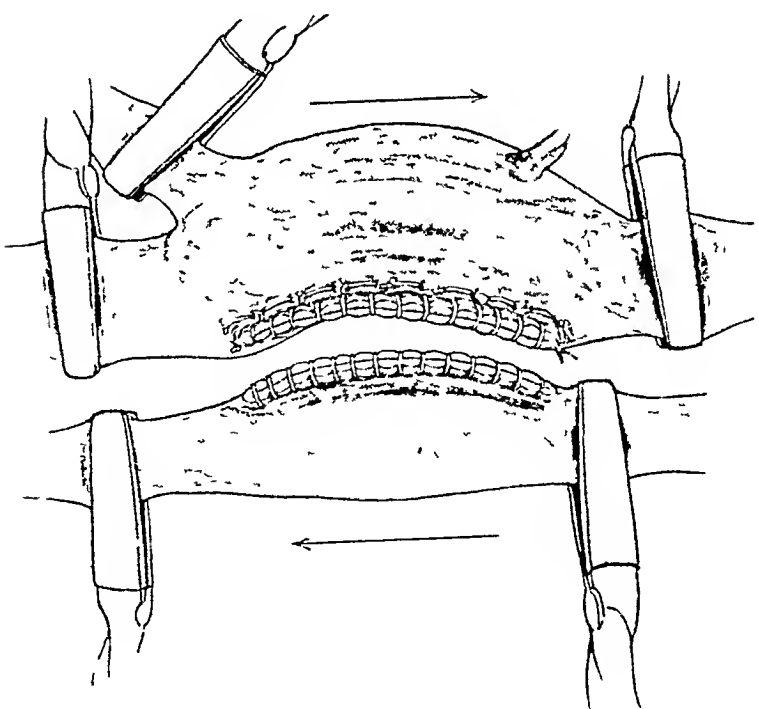
FIG 20 —Detail of anastomosis to show line of incision on the vein in order to expose the interior of the sac



VIII

FIG. 21.—Interior of the sac showing closure of the orifice of common cation by continued silk suture

Fig.



IX

FIG. 22.—The anastomosis closed, artery and vein detached isolated and separately closed by lateral arterio- and phleborrhaphy. The arterial orifice has been closed separately by intrascular suture on the expense side and the first line of intrascular sutures is reinforced at the expense of the vein

Fig.

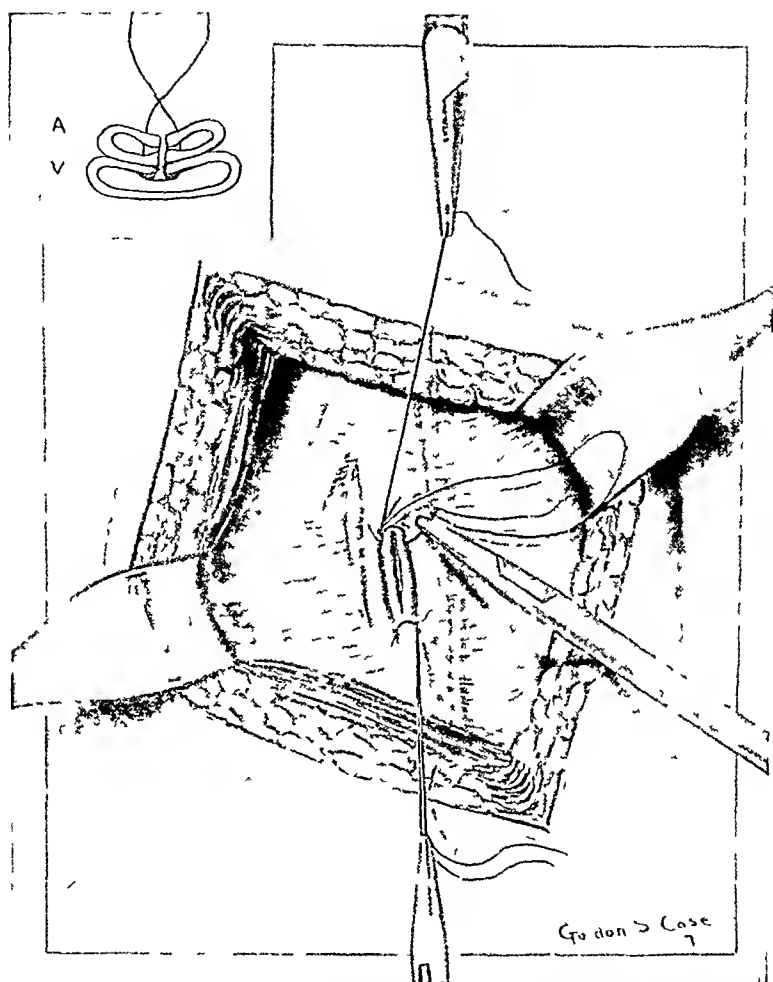


FIG 23—Case of Julius B—Arteriovenous aneurism of the femoral vessels at the apex of Scarpa's triangle. Shows interior of large space occupied by hematoma covered over with a veil of semitranslucent exudate in process of organization. First stage of the suture. In the upper diagram (a) the needle is shown penetrating through both walls of the artery and through the arteriovenous septum so as to close the narrow fistula which connected both vessels. By lifting the walls of the collapsed and thin vessels with two traction sutures one at each end the curved needle was able to penetrate the septum and obliterate the orifice in the vein as shown in the sketch (b) without obliterating its lumen.

exophthalmos caused by the dilatation of the retrobulbar veins, which gave him a very striking appearance (Fig 8)

Whenever he exerted himself he was seized with a dyspnœa and a great anxiety, which he attributed to the aneurism, as the veins swelled and formed a collar which he said "strangled him"

At first, I would not consider an operation, because I believed the cardiovascular lesions were so advanced that they would soon prove fatal. However, after observing him for one month, it occurred to me that the dyspnœic spells were, in part, due to the great strain imposed upon the right heart by the constant inflow of the enormous stream of arterial blood which was being short-circuited from the arterial into the venous system, through the fistula, at the abnormal jugulocarotid junction. For nearly fifteen years his heart had been able to stand the strain by compensatory hypertrophy, but now, in consequence of myocardial degenerative changes, it yielded to the strain at the slightest provocation, and he was in constant danger of an acute dilatation. It seemed to me that if the fistula could be closed the great strain on the heart would be relieved and his general condition improved. Chiefly for this reason I yielded to his urgent solicitation, but with grave misgivings as to the outcome which he fully realized.

Operation—I decided that I would operate in two stages. The first was to be limited to the clearing out of a great mass of superficial veins which were in the way and prevented a free access to the common carotid, then a removable aluminum band, of the type that we had been using for years for this purpose (Matas-Allen band), was to be placed on the artery with a view of testing the efficiency of the collateral circulation in the brain, through the circle of Willis. The first step was to end at this stage of the procedure, the wound was to be closed and the effect of the carotid occlusion on the brain was to be observed for several days. If no complications followed, the second stage was to be undertaken in a few days with a view of closing the arteriovenous fistula and curing the aneurism. This program was carried out to the letter, with some additions, on May 4, 1912. In view of the great dangers of general anæsthesia, the operation, in two stages, was performed under local and regional anæsthesia with novocain-adrenalin solution, preceded by a hypodermic of morphia gr $\frac{1}{4}$ and scopolamin gr $\frac{1}{150}$. The difficulties of the operation were just as great as we had anticipated, and in completing its first stage, two hours and a half were consumed in one of the most difficult, tedious, and trying dissections that I can remember in all my surgical experience. We were greatly assisted, however, by the patient's stoic and even cheerful attitude. He never complained and helped us at all times by placing his head and neck in the most favorable position for our work. In this way we were able to clear the field of the immense pulsating and squirming plexus of veins which covered the entire field from the submaxillary region to the sternum and clavicle with very little loss of blood and with all the deliberation and neatness of a cadaveric dissection.

(Fig 9) When this had been done the sternomastoid was divided at its sternal and clavicular attachments and reflected outwards, thereby exposing an immensely dilated jugular which completely overlapped and covered the carotid (Fig 10) After dividing the omohyoid and sternohyoid, the site of the anastomosis was easily recognized as a cicatricial plug which could be felt over the mass that bound the carotid and jugular with the sheath of the vessels and held them together in an inextricable, fused, pulsating mass Pressure at this point, which was the vortex of the great circulatory storm that raged in these parts, put an immediate stop to all pulsation and brought about the collapse of the veins We availed ourselves of this subsidence in the venous swelling to clear out the common carotid and apply the aluminum band on this trunk at about one and a half inches above the left sternoclavicular joint The seat of the anastomosis we had now located, with accurate precision, on a level with the bifurcation On releasing the pressure at this point, the jugular filled again and pulsated, but very much less vigorously than before the banding of the carotid In view of this greatly diminished activity of the arteriovenous circuit, an additional band was placed on the jugular about one inch from its junction with the subclavian Seeing now that the vein became distended and pulsated to the level of the obstruction, a chromic catgut ligature was placed on the vein an inch and a half higher up, and that much nearer to the anastomosis This reduced the size of the ampullar swelling very considerably, and, as the first stage of the operation had been completed, we decided to close the wound provisionally

Notwithstanding the long and tedious ordeal, the patient was sent back to his bed in excellent condition, with a pulse of 100, respiration 22, and in a cheerful frame of mind

In the absence of all complications, cerebral or otherwise, the second stage of the operation was undertaken on the third day after the operation, when the dressing was removed for the first time

Second Stage —On lifting the cutaneous flap the wound was found clean The occlusion of the carotid and internal jugular had exercised a wonderful influence in diminishing the venous turgescence and erethism of the whole field of the operation One significant fact remained the arteriovenous fistula at the carotid bifurcation was still active The pulsation and thrill could be still felt at this point, though greatly subdued It was evident that the arteriovenous fistula was now fed by the arterial current which was coming from the collaterals of the opposite side through the external carotid to the internal carotid and again into the jugular through the fistula (Figs 11 and 12) Evidently, the flow into the jugulo-carotid fistula could not be stopped, or the aneurism cured, until the circulation going on through the external and internal carotids had been arrested To accomplish this, these vessels were temporarily and individually compressed above their origin at the bifurcation with two small, padded Hoepfner clamps (Fig 12) The internal

jugular was now ligated on the cephalic side of the arteriovenous junction. This made it safe to proceed with the next step of the operation, which was to open the jugular vein freely over the site of the fistula and thus expose the interior of its ampullar swelling and close the orifice of communication leading to the artery through the venous side. A longitudinal incision of about one and a half inches was made into the venous pouch through the collapsed walls of the vein. The orifice of the fistula was now brought to view. It was elongated, oval shaped, and a little over a half inch in its longest diameter. Beyond it the lumen of the enlarged carotid could be recognized, and by passing a vaselined probe, the orifices of the internal and external carotids could be felt arising a short distance beyond the edge of the opening. The opening itself seemed to occupy the centre of a partition or diaphragm, formed by the adherent walls of the artery and vein. There was no interposed space or sac between the two. The edges of the fistulous orifice were smooth and rounded, and just thick enough to give a good firm grip to the small curved needle and paraffined silk that was used to close it. Six continued sutures passed through the edges of the opening were quite sufficient to close it hermetically (Fig 12). To secure further protection, a second line of continued chromic gut suture was made to cover the first line, by plicating the relaxed venous walls over it (Fig 13). This reduced the cavity of the venous sac to a notable extent, but still left a very considerable excess of sac, which was partially trimmed off with scissors sufficiently to permit the complete obliteration of the cavity by infolding the edges of the vein and holding them in apposition ("capitonnage") by a continued gut suture. In this way what was once a large venous ampulla was transformed into a thick padded cord which completely obliterated the jugular from the proximal to the distal ligatures which had been previously placed on the vein, above and below the anastomosis (Fig 14). The clamps were now removed from the external and internal carotids. It was soon determined that a reduced circulation had been established through these vessels, by way of the bifurcation, and that while the arteriovenous communication had been completely closed, a new channel for the arterial supply had remained. In this way, also, the main object of the operation had been obtained with a sacrifice of the vein, but with a greater conservative result on the arterial side than we had anticipated. This second sitting consumed, in all, about one and a half hours and was also carried out without any general anæsthetic, except a preliminary hypodermic of morphia and scopolamin. At the close, the wound was carefully dressed and drained at the lower angle.

All signs of the arteriovenous anastomosis had disappeared completely. From May 6 to 8 he continued to do well, only complaining of pain in swallowing. On dressing the wound on the 8th, evidences of suppuration and staphylococcal infection were discovered in the tract of the drain and several sutures were removed,

allowing some seropurulent fluid to escape. The infection had begun under the flap and a cellulitis was suspected between the lower carotid sheath and the pharynx. The pulse rose to 100 and showed more irregularity and intermittency. The mental attitude was perfectly clear and even cheerful, no evidences of cerebral disturbances. Dysphagia and occasional spells of dyspnoea were the chief troubles. The wound was dressed twice daily, and the infection seemed to be controlled. On the night of the 11th he became restless and anxious, and complained that he could not breathe comfortably and had to be propped up on pillows. On the morning of the 12th he washed his mouth and attended to his toilet as usual, but persisted in sitting up. At 8 30 A M he complained of sternocardiac pains and distress in the precordia and began to struggle for breath. The pulse now became very irregular and feeble and he expired suddenly before the interne of the service could reach him.

Death, therefore, occurred nine days after the first operation when the carotid and jugular were occluded, and on the sixth day after the second sitting, when the arteriovenous fistula was obliterated.

At autopsy nothing was found in the wound that could account for the fatal termination. The fistula had been completely sealed and all the sutures had held. The internal and external carotids were pervious and free from clot. The brain and thoracic organs were preserved for a separate and detailed examination in the laboratory. Marked evidences of chronic endarteritis and miliary aneurisms were discovered in the cerebral vessels, but the cause of the fatal termination was found in the heart. The aorta was dilated and showed atheromatous plaques. The left coronary was obstructed by thrombus and the right ventricle was distended with clot which extended into the pulmonary artery. The heart itself was of large size, dilated, showing evidence of myocardial degeneration.

I have dwelt with some detail upon the report of this patient's case because it presents many unusual, if not unique, features.

It is the first case that I have been able to discover in the literature in which the special technic of transvenous endo-aneurismorrhaphy has been applied to suppress an arteriovenous fistula of the jugulocarotid vessels with technical success. The only other instances that I can find, in which the *transvenous* method of endo-aneurismal suture has been applied, are reported six years later, and are (1) The operation performed on a young soldier by Rene Le Fort, of Lille, on July 20, 1917 (*Bull Acad de Méd*, Paris, No 31, August 7, 1917), in which the *internal* carotid and jugular veins were involved. The fistulous communication was closed by suture, applied through an incision made in the pouch formed by the dilated internal jugular. The artery remained pervious, and the vein was obliterated by plication and mattress sutures ("capitonnage"), as in my case. The wound had been inflicted four months previously, and the technic was remarkable for its simplicity and rapid recovery of the patient.

The operation reported by C P Lecene, of Paris (*Bull et mém soc de*

Chir de Par, January 15, 1918, xlv, No 1, 27-30), was performed on November 15, 1917. The patient, a soldier, aged twenty-five years, was wounded in the neck by a fragment of shell which perforated the common carotid and jugular, causing an arteriovenous anastomosis. The operation was performed about one month after the injury. In this case and in Le Fort's, the jugular vein was enormously dilated on a level with the arterial communication. The operator was able to close the slit-like opening of the fistula, which was clearly visible inside of the vein, by an intravenous suture with fine silk, and, in this way, he did a perfect restorative endo-aneurismorrhaphy, which allowed the common carotid to remain pervious. The vein itself was closed by intravenous sutures applied above and below the seat of the anastomosis. The result was a brilliant success, by which the carotid circulation was restored, though the vein was obliterated at the seat of the anastomosis.

This case, as the preceding of Le Fort, is noteworthy in many ways, and especially as illustrating the relative facility with which the cure of an aneurismal varix was effected in a particularly dangerous and difficult region. It is also a valuable tribute to the efficiency of the method, coming, as it does, from an operator who had previously entertained, and expressed, a decided prejudice against the endo-aneurismal methods of suture, but who, after this experience, loyally and honestly admitted that he had erred in his preconceived objections.

"Mais l'expérience qui seule juge en dernier ressort, m'a montré que mes préventions contre cette intervention [l'opération de Matas] étaient tout à fait injustifiées"

In my patient the continuity of the collateral arterial current to the brain through the external and internal carotids by way of the bifurcation remained undisturbed, and is also one of the unique features of this case. The proof that this collateral circuit remained active was demonstrated after the common carotid and internal jugular had been occluded.

The chief indication for the operation was also unusual, and perhaps unique, in the fact that it was undertaken chiefly with the hope that the closure of the arteriovenous fistula would relieve the strain on the right heart due to the short-circuiting of the carotid stream into the venous system, causing a progressive dilatation with dangerous and distressing symptoms.

VII The opportunity to test the full value and end-results of the transvenous route in attacking aneurismal varices, which was denied us in the preceding case, soon presented itself in a succession of aneurismal varices of the lower extremities, which came under treatment in our clinics in the interval between 1912 and 1919. The following two cases, abstracted from our records, suffice to show some of the peculiarities of the technic which has varied according to the conditions found in each case, but has always been guided by the same principle.

Traumatic Arteriovenous Aneurism (Aneurismal Varix) Involving the Femoral Vessels at the Groin, of Three Years' Standing, in which

the Arteriovenous Communication was Successfully Closed by Trans-venous Endo-aneurismorrhaphy, with Preservation of the Lumina of Both Vessels—The patient, J H H, aged nineteen years, of Westminster, S C, shot himself accidentally with a parlor rifle, 22-calibre bullet. The bullet entered the abdominal wall about one and a half inches below Poupart's ligament and ranged downward, striking the femoral vessels at the groin, and losing itself in the depths of the left thigh. A tumor formed just below the middle of Poupart's ligament where a characteristic thrill and purring noise developed on the third day following the injury. He came under my observation on January 11, 1912, *three years after* the accident occurred. The affected limb was larger than the right, and he had large varicosities all along the saphenous tract from the thigh to the leg, with typical pigmentation of the skin and a rebellious ulcer below the knee which had resisted all previous treatment. The site of the abnormal vascular communication was easily localized at a point just below Poupart's ligament, a little to the inner side of the midline. At this point, the pulsation, thrill and characteristic murmurs were heard with greatest intensity. From this point the murmurs and thrill were transmitted upward as far as the umbilicus and below as far as the knee. The details of the operation which followed are well shown in the accompanying diagrams and drawings (Figs 15-22). Iliac vessels were exposed by an extensive subperitoneal dissection, great difficulty being experienced in controlling the external iliac vein and its tributaries which had attained enormous proportions. The iliac vessels were provisionally controlled above and below the anastomosis (after Poupart's ligament had been divided) by elastic ligatures and padded clamps. The common femoral veins formed a large, well-defined sac of egg-like shape at the site of the fistula and at its junction with the saphenous. After controlling all the vessels, the aneurismal phenomena were all stilled and the vessels collapsed. The sac, which was fully three and a half inches in length and two inches in breadth, had developed between the artery and the vein, but at the expense of the vein. The constriction or neck which united the sac with the artery was fully one and one-half inches in length. The sac was opened longitudinally on the venous side, exposing the full length of the large orifice in the artery. This was closed by a row of continued, vaselined silk sutures introduced from the venous side, thus bringing the endothelial surfaces of the orifices in perfect apposition. After this, a cuff flap was cut off at the expense of the venous wall, thus detaching the artery completely from the vein. This flap was sutured over the cuff in the manner shown in the diagram, leaving the artery thoroughly protected against leakage. The suture of the vein was easily accomplished, owing to the excess and laxity of the venous sac. After this all the controlling elastic ligatures and clamps were removed, allowing the blood stream to return at once through its normal channel. All the sutures in the artery and vein held perfectly, insuring the complete success of the operation. The operation was

long and tedious, as was to be expected in such a chronic case, lasting nearly four hours. This was due chiefly to the innumerable and enormously dilated veins which had to be secured and ligated in the superficial planes before the main vessels could be reached (Figs 15 and 18).

The most notable post-operative feature of the case was the extraordinary tachycardia that developed suddenly after the restoration of the circulation through its normal channels. This tachycardia, during which the pulse ranged from 170 to 190, continued until after the patient had recovered from the anæsthesia and lasted for three hours after the patient was returned to his bed. At the end of this time the pulse suddenly became irregular and dropped in three minutes to 110, where it continued until it became normal the next day. Apart from this remarkable incident the patient made an excellent recovery and was discharged completely healed and well on February 19, 1912. Three years after his return home his physician wrote me that the boy had been in perfect health and that he had grown to be a big and robust man.

In this case, as in all others of long standing, the baneful effects of the short-circuiting of the large arterial channels, especially at the root of the limbs into the venous circulation, were particularly noticeable, and proved that the sudden readjustment of the circulation by the closure of the abnormal arteriovenous communication is not without its dangers.

Arteriovenous Aneurism of the Femoral Vessels at the Apex of Scarpa's Triangle in a Boy of Fifteen Years in which the Orifice of Communication was Closed by a Transarterial Suture. A Pulsating Hæmatoma Caused by the Simultaneous Transfixion of the Artery and Puncture of the Vein by Stab (Fig 23).—This boy, Julius B., was brought from Sterling City, Texas, September 3, 1916, twenty-four days after he had accidentally wounded himself in the right thigh with a long-bladed pocket knife while splitting a piece of wood. The knife had entered the upper thigh about five inches below Poupart's ligament. The boy was still suffering from the effects of severe hemorrhage. A linear scar indicated the point of entrance of the knife and about this was a spherical swelling which pulsed, purred and thrilled in the characteristic fashion of arteriovenous injuries. The pedal pulses were feeble, but on testing the collateral circulation by our methods, it was shown that an ample supply of blood was going to the periphery by the collaterals outside of the main channels, and that an obliterative operation could be performed with safety if it became necessary. Prophylactic hæmostasis was secured by the Esmarch bandage and the constrictor was held high up near the groin with a Wyeth pin. With the scar as the centre of the incision, a sac was opened above the sartorius which led to another cavity under this muscle. This cavity was already partially lined with a thin veil of organized exudates which hid the vessels completely. A slit-like opening about $\frac{1}{2}$ inch in length was now discovered in the floor of this space running parallel with the long

axis of the femoral vessels, which were lying superimposed one on the other under the thin lining of the sac. An exploration of this opening demonstrated that it led to the artery and not the vein, as we had at first supposed, and that this vessel had been transfixed and the vein punctured.

The flatness and breadth, as well as thinness of the collapsed artery, with the narrow slit-like wound lying in its centre, permitted us to suture and obliterate the arteriovenous opening simultaneously with the external wound in the artery. The technic adopted is shown in the accompanying Fig. 23. On removal of the constrictor, the blood rushed into the artery which pulsated, blood circulating on each side of the suture line and beyond, into the artery, distal to the central line of suture. All the aneurismal signs ceased completely and the circulation of the foot was perfect, the pedal pulses remaining as they had been before the operation. Healing took place *per primam*, and, after a short period of rest, hydrotherapy, and massage, the patient was discharged healed and well on the twentieth day after the operation. I have since heard from the patient, and up to the present time he is in perfect health.

This operation is unusual and perhaps unique in the fact that an arteriovenous fistula was obliterated through an abnormally thin arterial wall, thus constituting a trans-arterio-phleborrhaphy rather than the usual procedure of endo-phlebo-arteriorrhaphy.

IX. Our records show that four additional cases of arteriovenous aneurisms involving the femoral vessels have been operated upon in our clinics since going through the preceding experiences which exhibit individual features and peculiarities of special interest to the surgical technician which deserve detailed consideration in a separate publication. They all have the one feature in common, in that they were long standing aneurismal varices presenting all the difficulties and complications peculiar to the chronic stages of this class of lesions, each one offering a serious problem to tax the judgment, skill and resourcefulness of the most experienced operator. All of these, however, were happily solved by the intrasaccular methods herein described with such modifications as were suggested by the conditions met in the course of the operation. Finally, the experience gathered from these cases has convinced me that the possibilities of cure by this method are as great in arteriovenous aneurisms as in purely arterial.

X. Since writing these observations and in reviewing the history of the war, I am gratified to note that the aneurismal method of treating arteriovenous aneurisms by the intrasaccular suture of the communication orifice by the transvenous route, as described in this paper ("Matas-Bickham method") has been received with favor by Sir George Makins in his excellent monograph on "The Gunshot Wounds of the Blood-vessels" (London and New York, 1919). In referring to the treatment of aneurismal varix, he says "The indications for operation for this condition are less precise than in the case of the varicose aneurisms

There is no doubt that many aneurismal varices, especially in the upper extremity, do not call for operation, and may be left untouched without risk to the patient. Either pain, increasing local distention of the vein, or signs of increasing and troublesome obstruction to the peripheral venous circulation, may render operation advisable or necessary.

"The vessels may then be ligated above and below the level of communication and the varix excised. A far *preferable method is to close the communicating opening by suture*, as has already been described under the heading of arteriovenous aneurism. If a direct opening exists between the artery and vein, the latter should be opened freely, the communication is then exposed and may often be stitched up without any further preparation. If the sac be situated between the vessels, it should be opened first, and the communication can be stitched from this point."

Continuing on page 86, he again states "In pure aneurismal varices the almost invariable route to the anastomotic opening should be through the vein, if this procedure be adopted the closure of the opening into the artery is easy and that of the incision into the vein simple in the extreme," etc.

Here, then, we have a full acceptance of the intrasaccular suture applied by the transvenous route which Bickham first described in 1904, as an application of the method of endo-aneurismorrhaphy to arteriovenous aneurisms which I had described in 1903. While it is gratifying that so experienced and eminent a surgeon as Sir George Makins should have so clearly signified his approval of this method, it is surprising that one so well informed in the literature of vascular surgery nowhere suggests or even hints in his book that this method had been devised, described, and applied in America ten years before the declaration of the war. In this he differs from his French colleagues, Lecène, Forgue, and others, who fully recognize the antebellum as well as the American origin of the method.

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STUDY OF ARTERIOVENOUS FISTULA WITH AN ANALYSIS OF 447 CASES

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THE original paper, of which this article is a part, was published in volume xix of the Johns Hopkins Hospital Reports, and was written at the suggestion of Prof William S Halsted, who generously placed at my disposal all the material collected by him in the course of his study of arteriovenous fistula

The earlier, more complete publication dealt specifically with each of the cases in the literature and recorded them in the form of a detailed and analytic chart and included, in addition, a complete bibliography for all instances mentioned in the text and charts

Doctor Halsted's particular interest in this subject arose from his effort to determine the cause of the proximal dilatation of the artery, which has been observed in a number of these cases, and which he believes occurs invariably

In his writings he has expressed the view that the dilatation of the artery which is (1) distal to the partially occluding band, (2) beyond the site of coarctation in cases of congenital stricture of the aortic isthmus, and (3) distal to the constriction of the subclavian artery by a cervical rib will be found to have the same cause as the dilatation of the artery central to an arteriovenous aneurism The subject is discussed in his papers published in the *Journal of Experimental Medicine*,¹ the *Proceedings of the National Academy of Sciences*,² and in *Surgery, Gynecology, and Obstetrics*³

Doctor Halsted's interest in the study was further stimulated by the conviction that an arteriovenous fistula may be responsible for the enlargement of the heart, which he has repeatedly observed as a complica-

¹ Halsted, W S An experimental study of circumscribed dilation of an artery immediately distal to a partially occluding band, and its bearing on the dilation of the subclavian artery observed in certain cases of cervical rib

Reid, Mont R Partial occlusion of the aorta with the metallic band Observations on blood-pressure and changes in the arterial walls *Jour Experimental Medicine*, 1916, xxiv, p 271

² Dilation of the great arteries distal to partially occluding bands *Proc of the Nat Academy of Sciences*, 1918, iv, p 204

³ Cylindrical dilatation of the common carotid artery following partial occlusion of the innominate and ligation of the subclavian *Surgery, Gynecology, and Obstetrics*, 1918, xxvii, p 547

ARTERIOVENOUS FISTULA

tion in these cases, and which Dr Mont Reid, at his suggestion, has attempted (and with success) to prove

This study is carried to the year 1914, but, in addition, reviews all the cases recorded among the surgical histories of The Johns Hopkins Hospital, as well as a number of selected instances appearing in the surgical literature of the recent war

I HISTORY OF ARTERIOVENOUS ANEURISM

To William Hunter undoubtedly belongs the credit of first describing accurately not only the clinical features, but also the disturbed mechanism of the vascular physiology of arteriovenous fistula. This he did in 1757, and this analysis was followed in 1762 by the detailed publication of the two cases which formed the basis for his description and conclusions

An excerpt from the account of his first case reads

About fourteen years ago a lady was bled in the basilic vein of the arm by a surgeon who was unfortunate enough to wound the artery through the sides of the vein. He was instantly sensible of the misfortune by the violence of the stream that gushed from the vein. At the time of the accident, and for a great while afterwards, every method that could be suggested was taken for preventing or curing an aneurism by compression.

The veins in the bending of the arm, and especially the basilic, the vein that had been opened, were prodigiously enlarged at that place and came gradually to their natural size about two inches above and as much below the elbow. When emptied by pressure they filled again almost immediately, and this happened even when a ligature was applied tight about the forearm immediately below the affected part. Both when the ligature was made tight and when it was removed they shrunk and remained of a small size while the finger was kept tight upon the artery at the point where the vein had been opened in bleeding. There was a general swelling and fulness at the affected part and in the course of the artery, which seemed to be larger and to beat stronger than what is natural all the way down the arm. There was likewise a pulsation in the dilated veins corresponding to the pulse in the artery, and there was a hissing sound and a tremulous jarring motion in the veins, which was very remarkable at the part which had been punctured, and became insensible at some distance both upwards and downwards.

Though such a case has never before entered my thought, I was so well convinced by the symptoms of its arising from a communication between the artery and the vein that I gave an opinion to that purpose, and, therefore, advised her to do nothing while there should be no considerable alteration.

The following extract concerns Hunter's second case

A male who was bled in the arm about five years previous to the examination. The trunk of the brachial artery is considerably enlarged all the way down the arm, and its pulsation so strong that it is apparent to the sight. A little above the bend of the arm the artery makes a remarkable serpentine turn, which raised up the skin, and by the force of the pulsation looks as if it was a beginning aneurism. But notwithstanding the size and force of pulsation of the brachial artery be much more considerable than in the other arm, the artery at the wrist is much smaller and its pulsation much weaker. Whence it is evident the disorder

has brought on a great disproportion in size between the dilated trunk and the shrunk branches of the artery in the diseased arm

At that place where the puncture was made, a bag rises up, projecting as much as if it were a large nutmeg under the skin. This bag is filled entirely with fluid blood, disappears under pressure, and has a strong pulsation. Its deepest part is manifestly united with the artery. Over the inside and the most prominent part of this bag the basilic vein runs, and is so firmly united to it and blended with it by communication that it is difficult to determine whether the bag be a sinuous dilation of the part of the vein or if it be an adventitious cavity between the artery and vein formed in the cellular membrane, though I am more inclined to believe the last. Its communication, however, both with the artery and vein, is undoubted, as will appear by what follows.

The basilic vein is very much enlarged, and its extension is very apparent and makes a considerable external swelling. But when the arm is held up so as to give the returning blood the advantage of running downwards, the vein subsides and no swelling whatever appears, except just at the punctured place, where the bag continues nearly as much dilated as when the arm hangs down.

There is a remarkable tremulous motion (as well as considerable pulsation), both in the bag and in the dilated vein, as if the blood was squirted into it through a small hole. It is like what is produced in the mouth by continuing the sound of the letter "R" in a whisper. It is the strongest at the very place where the vein was punctured, and becomes gradually less perceptible from that part upwards. It is even very apparent to the sight. It is entirely stopped by pressing the trunk of the artery anywhere above, or by pressing the bag or the vein at the punctured part, and there the very point of the finger is of sufficient breadth for the purpose. These compressions instantly stop the tremulous motion, and it instantly returns again when they cease. It is the same when the arm hangs down and when held up, and when loose and girded by a ligature below the punctured part.

This motion is not only felt and seen distinctly, but heard if the ear be held near the part, and if the ear touches the skin the sound is much more loud and distinct. It is a hissing noise, as if there was a blast of air through a small hole and interrupted, answering precisely and constantly to the stroke of the heart or the diastole of the artery. It stops immediately when the trunk of the artery is compressed and returns instantly when the artery is free. The patient is so sensible of the noise that he often finds that it keeps him from falling to sleep when the arm happens to be near his head, and then commonly puts it down by his side in bed that he may go to rest.

If one looks with attention while the compression is taken from the artery, you can trace the blood rushing first down the artery, then across the bag, and last of all, flying upwards in the vein.

Guattini, an Italian, who in 1785 published an accurate description of this type of aneurism, was by Scarpa given joint credit with Hunter for the discovery. Eighteen years, however, had elapsed between Hunter's report and that of Guattini. Moreover, in that interval Cleghorn, White and Armiger had each published detailed descriptions of arteriovenous aneurisms of the brachial vessels.

To Sennert, too, different authors have unfairly attributed the credit of this discovery, but he, as did other foregoing observers, misconstrued undoubted cases of arteriovenous fistula as cases of simple arterial aneurism.

It is interesting to note that this discovery did not take place until the middle of the eighteenth century, after the lancet mode of venesection

ARTERIOVENOUS FISTULA

had been in vogue for years. Since it had been practiced in many instances by men little versed in the arts of anatomy and surgery, it follows fairly logically that simultaneous wounds of the artery and vein were fairly common long before the discovery was made. If the phenomena consequent upon the union of artery and vein were present, they were mistaken for evidences of arterial aneurism.

New observations followed at an early date, but Delacombe, in France, published the first case of arteriovenous aneurism in which the clinical findings were confirmed by the lesions found at autopsy.

The later theses of Morvan, Goupil, Henry, and others, together with a monograph by Delbet and a paper by Bramann, have done much to clear up the various phases of the clinical and pathological pictures.

II CLASSIFICATION

Definition of Arteriovenous Aneurism—By arteriovenous aneurism is meant any pathological union between an arterial and a venous channel, whether that communication exists between a systemic artery and vein, between an artery and a venous sinus, or between the aorta and the right ventricle, the right auricle, or the pulmonary artery. These communications fall naturally into different varieties according to certain definite changes in form and structure obtaining in the various parts of this complex.

Aneurismal Varix—The simplest form of such communication is that in which no saccular dilatation, true or false, springs from the artery, vein, or channel of communication (Fig 1). This variety was called by Broca *phlebotémie simple*, but in the general, more confusing nomenclature, bears Cleghorn's designation *aneurismal varix*. Here the wounds of the artery and vein are approximated and become agglutinated with a single orifice of communication. In addition, there is a gradual dilatation of the vein. This tumor is *aneurismal*, having communication with the arterial circulation, and because of its venous dilatation is designated as *varix*.

The anatomic factors governing the formation of this type of aneurism are the proximity of the involved vessels, the space afforded them in the vascular cleft, and the amount of support given them by the surrounding tissue (Makins).

Varicose Aneurism by Dilatation—When the vein increases in size and bellies out into a circumscribed swelling, and when that dilatation involves only the walls of the expanded vein, the resulting aneurism was called by Broca *varicose aneurism by dilatation*. It seems arbitrary, however, to distinguish between this type and that which constitutes aneurismal varix, for one may readily pass from the one into the other by the most insensible gradations.

Encysted Varicose Aneurism—In another group of cases, the details of the injury are such that either artery or vein, or both artery and vein,

are transpierced, affording channels for arterial or venous extravasations into the tissues. Although the edges of the arterial and venous wounds destined to form the fistulous communication may early become approximated, the other vascular wound or wounds may remain patulous. In this instance a false aneurismal cyst or cysts, with walls formed from perivascular tissue and laminated clot, will occur at the unhealed sites of injury, and it is the connection of these false circumscribed sacs which furnishes the basis for subdivisions of this variety. When the cyst of new formation surmounts the vein, the *encysted varicose aneurism* is designated as *venous* (Fig 3), but when this sac rests singly on the artery, the aneurism is known as *arterial encysted varicose aneurism* (Fig 2). When false aneurismal cysts are noted upon both the artery and the vein, the resulting rare aneurism is termed *double arterial and venous encysted varicose aneurism* (Figs 4 and 5).

Intermediate Encysted Varicose Aneurism—In a certain group of cases where a profuse extravasation of blood has occurred at the point of injury, so situated as to separate the artery and vein and to prevent their adhesion and union, and forming a false aneurismal sac which serves as a channel of communication, the tumor is known as an *intermediate encysted varicose aneurism* (Figs 6 and 7).

Were the above condition to appear combined with superimposed false sac on either the artery or the vein, the complex is known as *double arterial or venous and intermediate encysted varicose aneurism* (Fig 8).

To Cruveilhier, in 1853, we are indebted for the essential features of the above classification.

Arteriovenous Aneurism—A very rare type of aneurism in which an artery has a fistulous communication with two veins may be designated as an *arteriovenous aneurism*. Such anatomic relations existed in Park's brachial and Mignon's axillary fistula (Fig 9).

Chauveau reported an arteriovenous aneurism of a most curious variety, occurring on the jaw of a horse embracing the muscular maxillary artery and vein. From this thin and dilated artery, there arose five or six large flexuous branches, ampulliform at their origins, making large mutually anastomosing ramifications on the walls of the venous sac. Definite communication existed between these arterial anastomoses and the dilated vasa vasorum in the wall of the varicose vein, and these again communicated directly with the main channel of the vein. This complex Chauveau describes as an *arteriovenous aneurism by dilatation of the vasa vasorum of a varicose vein* (Fig 10).

III ETIOLOGY

The predominating cause of arteriovenous aneurism is some form of traumatism. The detailed table of causes given below will show that in a total of 447 cases 383, or 85.7 per cent, resulted from injury.

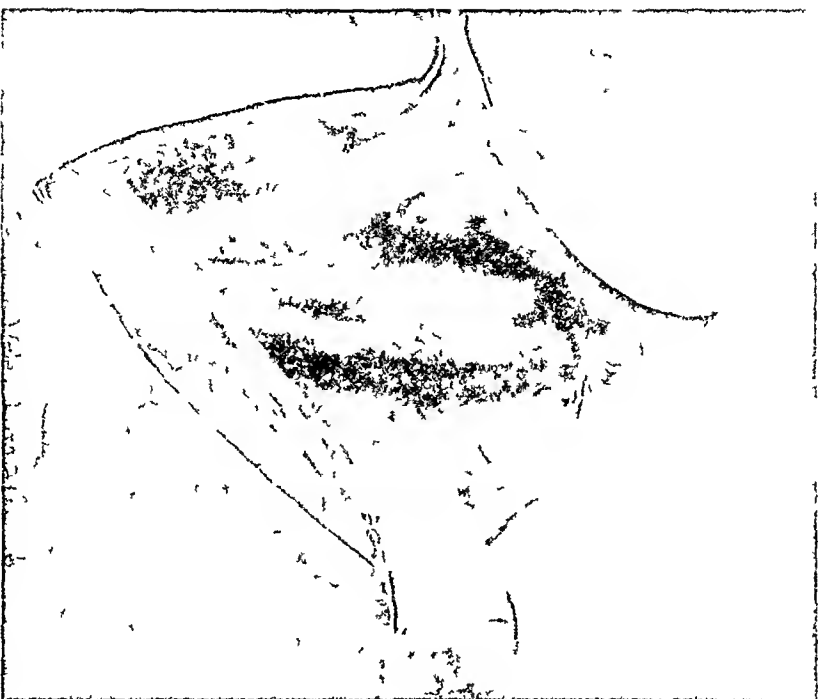


FIG. 1.—Aneurysmal varix of the femoral artery and vein. Horsley
Med and Surg 1917 1 25--29

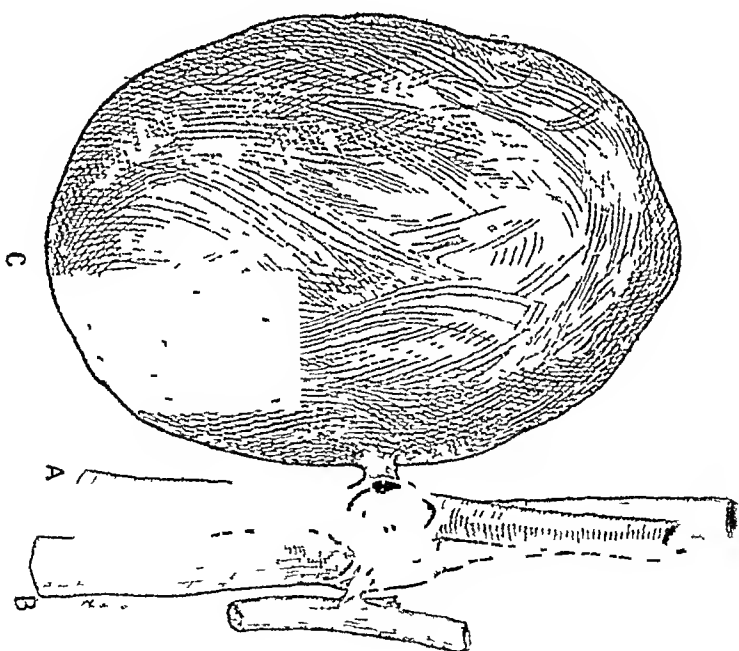


FIG. 2.—Arterial encysted varicose aneurysm of the femoral vessels
Guinard Bull et mem Soc de Chir n s 1902 LVIII, 1125

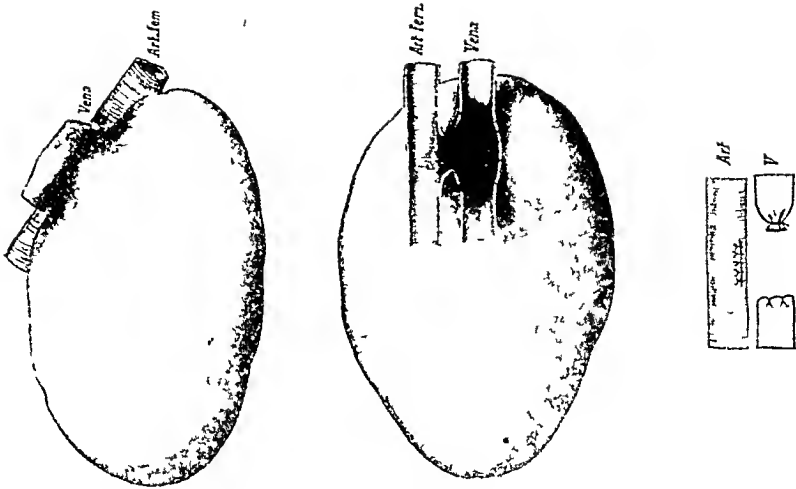


Fig 1

FIG 3 —Venous encysted varicose aneurism of the femoral vessels Garre Deutsche Ztschr f Chir 1906 lxxxviii 287

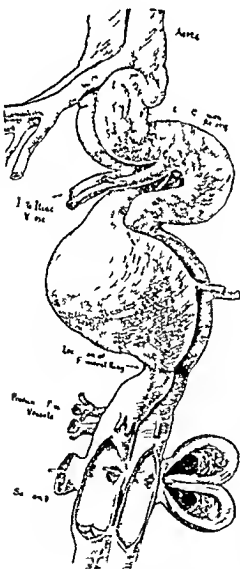


FIG 4 —Double arterial and venous encysted varicose aneurism of the femoral vessels Eisenbrey J Am Med Assn 1913 lvi 2155

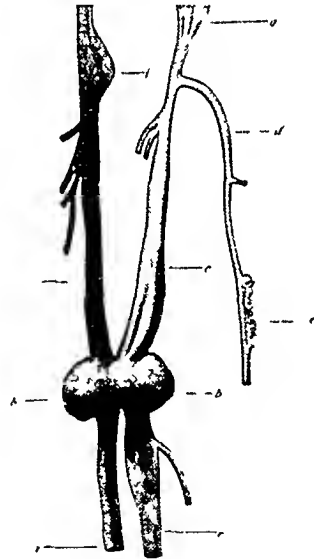


FIG 5 —Double arterial and venous encysted varicose aneurism of the femoral vessels Gallerand Arch de mcd nav 1882 xxxviii 146

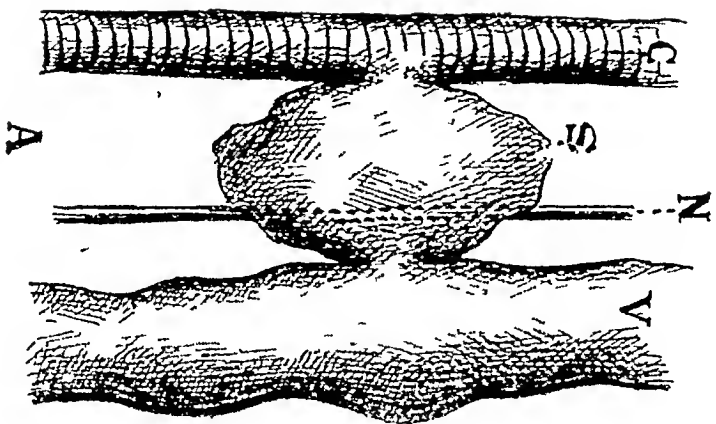


FIG 6.—Intermediate encysted varicose aneurism of the common carotid artery and internal jugular vein. Cranwell. Rev de Chir., LVIV, 1906, 826

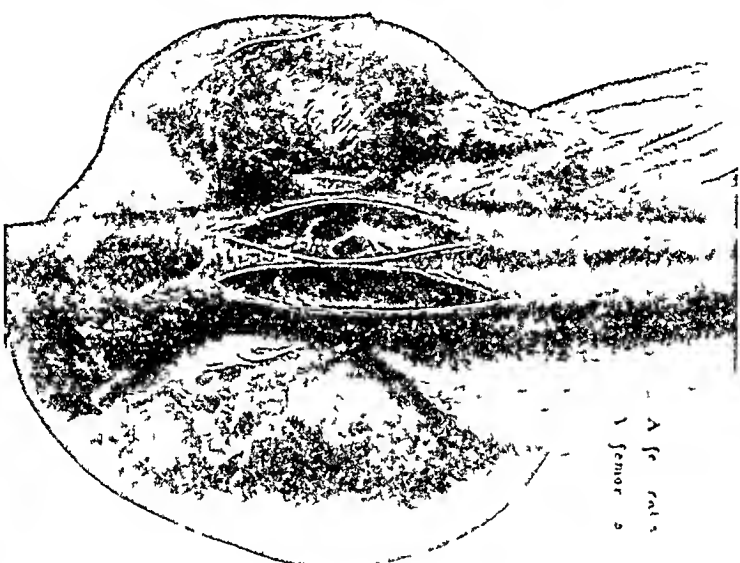


FIG 7.—Intermediate encysted varicose aneurism of the femoral vessels. MacCallum's Textbook of Pathology

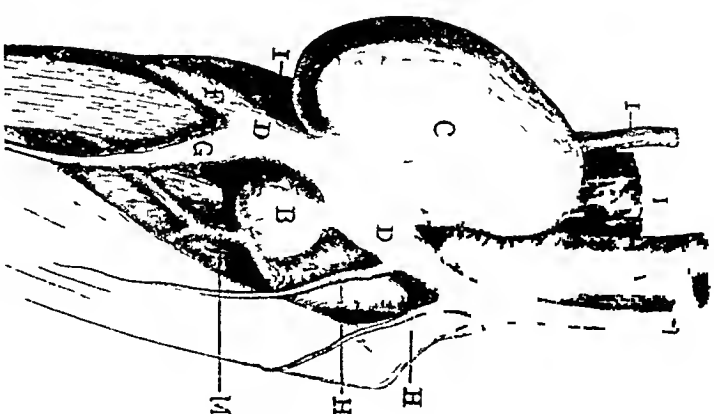


FIG 8.—Double venous and intermediate encysted varicose aneurism of the brachial vessels. Broca. Bull de la Soc de Chir. 2 d s., 1863 IV, 392

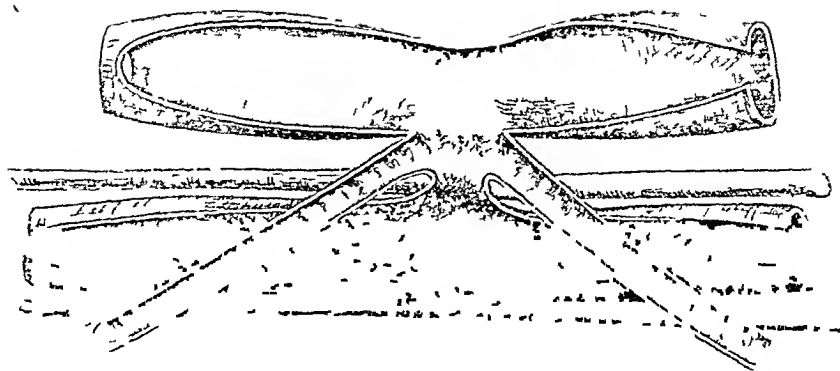


FIG 9 —Arterio bi venous aneurism of the axillary vessels Mignon Bull et mem de
Soc de Chir n s 1905 xxxi 535

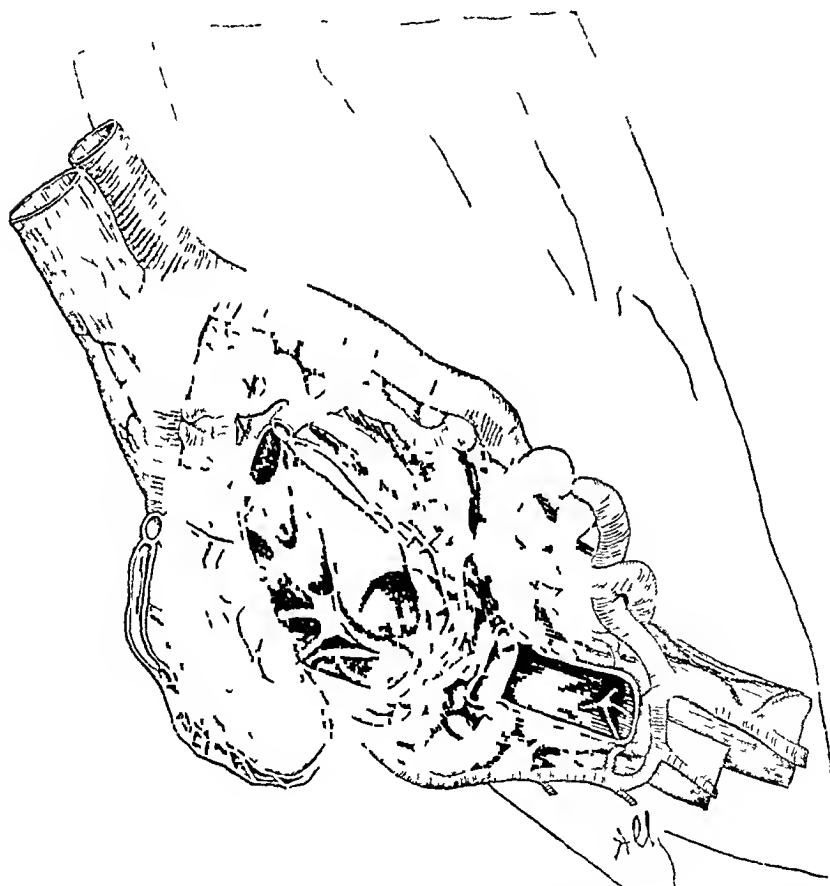


FIG 10 —Arteriovenous aneurism of vasa vasorum of varicose vein Chauveau Jour de
la physiologie de l homme 1860 iii 683-694

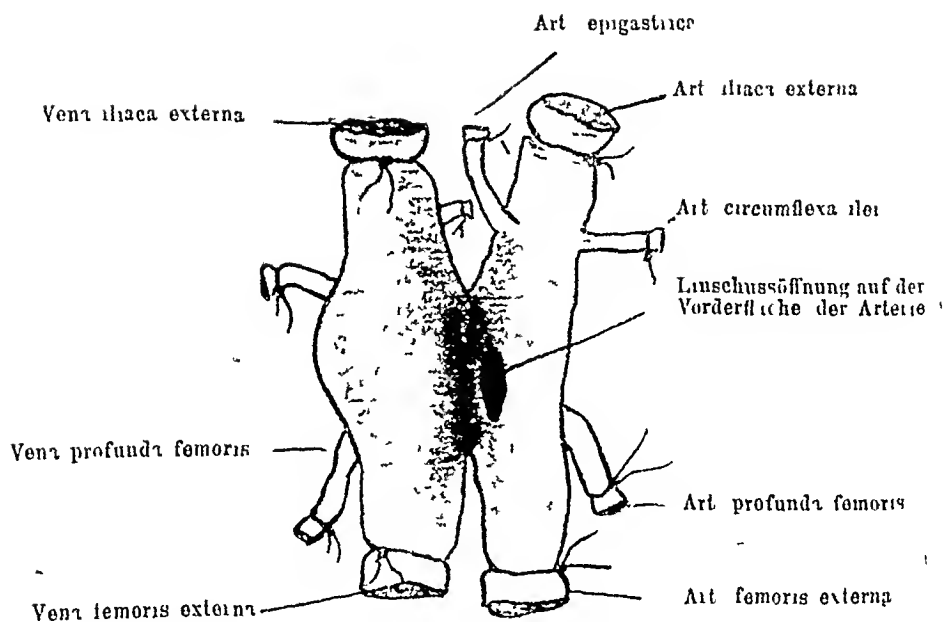


FIG 11 —Extirpation of aneurism in aneurismal varix of the femoral vessels Thiel
Centr f Chir, 1859 xxi, 1226

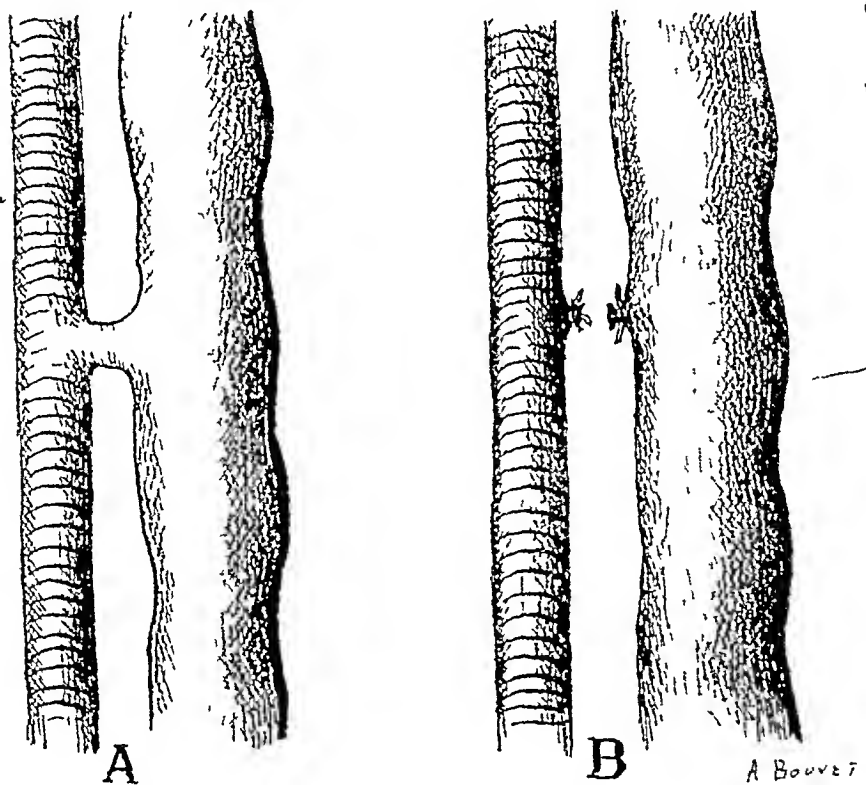


FIG 12 —Ligation of the communication in aneurismal varix of the popliteal vessels
Cranwell Rev de Chir, 1906 xxiv, 824

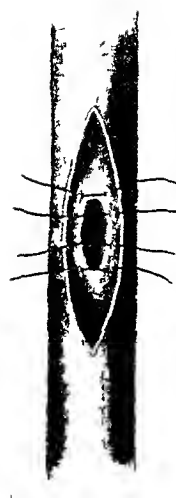


Fig. 12.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.



Fig. 13.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

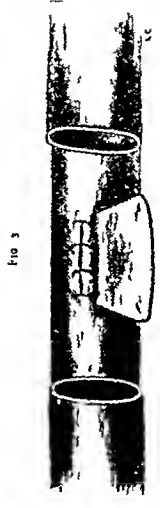


Fig. 14.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.



Fig. 15.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

Fig. 16.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

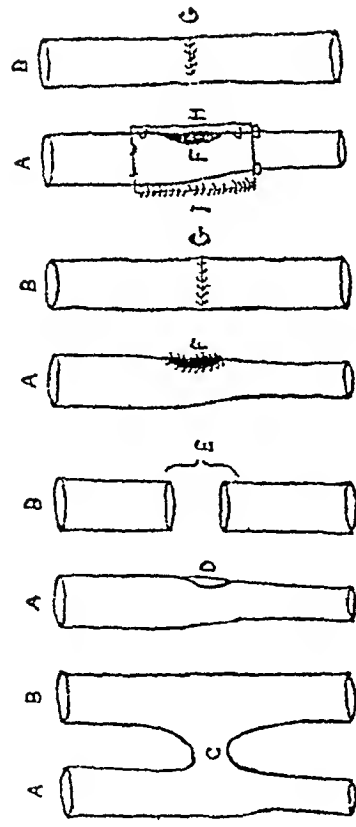


Fig. 1.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

Fig. 2.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

Fig. 3.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

Fig. 4.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

Fig. 5.—Lateral suture of the artery and end to end suture of the vein in popliteal aneurysm.

Fig. 14.—Lateral reinforced suture of the artery with resection and end to end suture of the vein in popliteal aneurysm. Da Costa ANN SURG 1912 IV 593

Fig. 13.—Lateral suture and reinforcement of artery and end to end suture of vein in aneurysm of the femoral vessels. A artery B vein C communication between artery and vein D hole in artery after dissecting out communication and refreshing edges, E the two ends of the veins ready for end to end anastomosis F artery having been cut away in order to get healthy vein tissue for anastomosis G vein sutured laterally with fine silk sutures G vein sutured end to end anastomosis, H graft from internal saphenous vein surrounding the sutured artery and sutured on opposite side to sutured artery at I Godwin Brit Med J 1915 II 925

ARTERIOVENOUS FISTULA

Projectiles	189
Bullet	166
Bomb	2
Shrapnel	5
Shell	9
Piece of metal	6
Grenade	1
Knife wounds	161
Venesection	38
Cuts and stabs	123
Contusions	28
Fractures	5
Secondary aneurism	20
Doubtful origin	7
Congenital	3
Unknown	34
	<hr/>
Total	447

Of the main traumatic factors, wounds from projectiles and knives played about an equal rôle, 189 cases resulting from the former and 161 cases from the latter

Bullet Wounds—The bullet was the causative factor in 166 instances, and its more extended use in modern warfare has made arteriovenous aneurism as familiar now as it formerly was from promiscuous venesection

In the earlier wars the occurrence of arteriovenous aneurism from bullet wounds was rare, for among 400 vascular injuries in the service of Demme in the North Italian Military Hospital in 1859 not a single case of arteriovenous aneurism was reported, nor were any noted in the Crimean War. Only 8 cases were reported from the Franco-Prussian War in 1870-1871. In this regard Kuttner remarked that aneurisms were usually associated with injuries of large arteries, and their occurrence was infrequent in those wars because of the larger wounds and the frequent hemorrhages. In modern warfare, however, conditions are exactly the opposite and aneurisms constitute a very interesting class of war wounds.

According to von Bergmann, arteriovenous aneurism results from the clean, narrow puncture so liable to occur with the rapidly formed, penetrating wounds caused by the small calibre bullet. The conditions associated with the formation of traumatic arterial aneurisms are identically those required for the production of the arteriovenous variety, namely a small orifice of entrance and exit for the bullet, a narrow but long curved channel usually crossing the course of the vessels in an oblique direction, a small perforation in the artery, followed by rapid closure of the wound and primary union of the bullet's track.

Such conditions prevailed during the more recent and the late wars

In the official report from the surgical cases noted in the South African War, 1899-1902, Surgeon General Stevenson, of England, reported 63 cases of traumatic aneurism, of which 33, or almost 50 per cent, were of the arteriovenous variety. Saigo, writing on traumatic aneurisms in the Russian-Japanese War, found approximately the same proportion.

A variety of *bomb, shrapnel, and grenade wounds* account for 23 additional cases. It is interesting to note the increasing frequency of arteriovenous aneurisms caused by explosives since Breemann, in 1886, gave his excellent analysis of 159 cases in which only 29, or 18.2 per cent, resulted from this general source. In our series of 447 cases, 189 were caused by injury from projectiles, making a total of 42.2 per cent. The incidence of arteriovenous aneurism in the later decades is noticeably greater.

Cut and Stab Wounds—Cut and stab wounds, including injuries by lancet, knife, stake, chisel, bayonet, and spike, are responsible for 161 aneurisms, or 36 per cent.

Arteriovenous aneurism resulting from venesection has in recent years become of comparatively rare occurrence, for indiscriminate and inefficient bleeding has ceased to be a practice of modern medicine, and the unintended consequences of the measures have therefore ceased to be frequent. Among Breemann's collection of 159 cases 56, or 35.2 per cent, resulted from venesection. In Delbet's series of 250 aneurisms, 92 cases, or 36.8 per cent, resulted from this source. In 447 cases in this series only 38, or 8.5 per cent, followed venesection.

Contusion—The nine cases falling under the heading of contusion are made up indiscriminately of injuries no more specific than blow, fall, trauma, injury, and wound, and include an aneurism reported by Robinson in an amputation stump of the knee.

According to Matas, the aneurismal varices occurring in amputation stumps are usually associated with massive ligatures of both vessels followed by infection.

Fracture—Fracture was the traumatizing agent in the injury of the vessels in the following five cases. Cushing's aneurism of the internal carotid artery and the internal jugular vein from a fracture of the skull, Gross and Sencert's fistula of the anterior tibial vessels from a fracture of the leg, Reboul's subclavian aneurism from a fracture of the clavicle, Findlay's femoral aneurism from a fracture of the femur, and Bornhaupt's aneurism of the brachial vessels from a fracture of the humerus.

Secondary Aneurism—There is a group of twenty secondary arteriovenous aneurisms which followed the erosion into neighboring venous channels of preëxisting arterial aneurisms of the ascending and the abdominal aorta.

Congenital—In three cases the fistulæ were present from birth. Sir Prescott Hewett reports an arteriovenous aneurism of the common iliac vessels in a hydrocephalic in whom the right thigh at birth was larger than the left, and the superficial veins of which were engorged. In

Busche's temporal fistula a pulsating tumor the size of an egg had existed since birth. In Halsted's aneurism about the external carotid artery a buzzing and throbbing in the right side of the neck was noticed when the patient was three days old.

IV PATHOLOGY AND PATHOLOGICAL PHYSIOLOGY

Venous Dilatation—An ever-increasing dilatation of the vein about the fistulous communication is one of the most constant features of arteriovenous aneurism. This dilatation may be more or less uniform and may extend over a considerable portion of the whole vein, or may be at its maximum at the point of communication. The fundamental cause of these venous changes is the increased pressure in the veins produced by the passage in them of arterial blood.

Normally, the pressure of the blood in the veins is slight, and the venous blood in them is carried by the *vis a tergo* communicated through the capillaries, aided by such other influences as the pressure of the contracting muscles, the changing position of the limbs, and the suction exerted by the thorax during the inspiration. The numerous valves placed along their course preserve each advance as it is made, and protect the underlying vessels from the extension to them of any accidental increase in the trunk above.

When arterial blood passes directly from an artery into its corresponding vein, it does so under a pressure which far exceeds the normal blood-pressure in that vein, and, since it cannot escape toward the heart without lifting and rapidly pushing before it the venous column on the proximal side, the increased pressure must be exerted on the lateral wall of the vein. Under such increased pressure the wall of the vein yields and its lumen enlarges. So long as the calibre of the vein increases and the vein valves distal to the communication remain sufficient, this added arterial pressure is not transmitted directly into the column of blood in the peripheral vein, but merely obstructs its central passage to the heart by imposing an obstacle against it. When, however, the valves yield under pressure, or become insufficient from the enlargement of the vein, and the arterial pressure is transmitted against those segments thus deprived of protection, the same changes in turn occur in them and a consequent dilatation of the vein ensues.

Pressure conditions peculiar to the internal jugular vein and other large veins of the neck account for a marked abnormality in that region. Stimson was the first to note that in the internal jugular vein the blood, instead of being pushed by the *vis a tergo*, is being pulled or drawn along by the *vis a fronte*, the strong suction of the chest at each inspiration, and the feebler one of the elastic return of the lung upon itself during inspiration. Instead of being distended, the wall of the vein is habitually flaccid, and the pressure in it is low or even negative. In addition, its

lumen is very large and it communicates within a very short distance with other trunks whose lumina are as large as its own, in which also the pressure is negative and into which, therefore, any excess of blood will readily escape. In other words, if there is an aneurismal dilatation or sac it is not large and has no tendency to grow larger. The average internal pressure is low because the incoming blood is no longer confined, but escapes into the vein as readily as it enters from the artery, and is thus prevented from exerting a distending influence on the wall of the dilatation or sac. The change, once established, has no tendency to increase. Stimson's postulate finds ample verification and corroboration in the study of the aneurisms of the common carotid artery and the internal jugular vein occurring in this series.

When, on the other hand, the external jugular vein is involved, and where conditions more nearly resemble those found in the other parts of the body, and where the venous escape to the heart is less free, there is a resulting dilatation of the vein.

The extent and location of the dilatation of the vein are dependent upon several well-recognized factors. First, the size of the communication determines the amount of arterial blood diverted through the fistula exerting pressure on the vein, second, the resistance afforded by the varying denseness of the perivascular tissue, third, the duration of the fistula, fourth, the degree of patency of the central segment of the vein, and fifth, the influence of gravity.

Venous Hypertrophy—Although occasional large sacculations may be met with, as a rule, the veins support their increased vascular tension to an unexpected degree, owing to the acquired hypertrophy of the muscular coat. This ability of the vein to hypertrophy and to assume the work of an artery is shown in no more conclusive manner than by the admirable experiments of Alexis Carrel, who has demonstrated the feasibility of transplanting a segment of vein into an arterial defect several centimetres long by means of a double end-to-end suture. "Aided by the support of the surrounding tissues and by its own hypertrophy, the interposed segment of the vein, after a temporary slight ballooning, soon effectively plays the part of the thick-walled artery for which it has been substituted." The changed appearance of the vein, due to the hypertrophy of its muscular coat, has been termed *arterialization*.

There has been considerable controversy over the reason for these changes, Breschet alone contending against an explanation on purely mechanical grounds, and considering them the result of chemical changes in their walls wrought by the influx of arterial blood.

Pathological Changes in Vein Valves—The vein valves, since they play a most important mechanical rôle in protecting the distal venous column from abuse, show important changes. As the lumen of the vein increases and the head pressure from the artery continues, the burden of the valve becomes increasingly heavy, until pair by pair they become insufficient.

In Socin's femoral fistula of nineteen days' duration, the first set of valves distal to the communication were almost destroyed, whereas the set next below were intact, while with fistulæ acting over a longer duration the valves at a greater peripheral distance fail to function. In Bramann's axillary aneurism of one and one-half years' duration, the valves, as far distally as the opening of the median basilic vein, were insufficient, and an examination of one of them located at some distance from the fistula showed one segment much shrunk, forming a ridge in the lumen of the vessel, with the other torn and lying adhered to the side of the vein.

Rokitansky pointed out that valvular hypertrophy took place below that point in the distal segment of the vein where a moderately increased but continuous arterial pressure was maintained. This feature is illustrated in Rokitansky's own axillary aneurism and Robert's femoral aneurism.

According to Matas, the resistance of the valves favors the dilatation of the vein in segments, forming tumors which vary from the size of a pea to that of a large egg, or even to a foetal head.

Changes in the Internal Saphenous Vein—It is important here to make certain observations relative to anatomic characteristics peculiar to the internal saphenous vein, such as the extraordinarily strong valves at its mouth, and an absence of anastomosis with the deeper veins. J. Gay and W. Braune have demonstrated that but one small anastomosis exists between this long saphenous and the deep veins of the thigh. Because of these findings, there are here remarkably few instances of the pathological changes found elsewhere. In three cases of femoral aneurisms only—those of Pemberton, Gallerand, and Davies-Colley—did dilatation and hypertrophy occur.

Bone and Calcium Deposits about the Fistula—At various stages in aneurism formation, unusual bone and calcium deposits have been noted on the walls of the sac in the immediate vicinity of the fistula. Zöge von Manteuffel reported an ossified varicose aneurism of the femoral vessels of only four weeks' duration, which communicated directly with the marrow cavity of the femur. Gallerand's femoral aneurism was found to be hard and cornified throughout, and intimately attached to the femur, it contained numerous phleboliths which the author asserted were mere fibrinous clots which had undergone calcium metamorphosis. The sac wall of Trélat's popliteal aneurism was semi-flexible, thick, and resistant, and as difficult to cut as a piece of leather, while its internal surface was studded with calcified and atheromatous plaques. In Beaumont's aneurism of the femoral vessels a small deposit of calcareous material was noted in the laminated fibrin suspended in the sac. Intramural calcium deposits were seen in the femoral aneurisms of Perry, von Wahl, and Eisenbrey.

Organized laminated clot within the aneurism, though rarely seen, has been reported in the cases of Beaumont and Eisenbrey.

Proximal Dilatation of the Artery—Hunter, in 1762, recognized the

dilatation of the artery proximal to the fistula in his two cases and attributed it to the lessened work which the artery was called upon to perform

According to Hodgson, "The enlargement of the artery above the tumor appears to be the effect of that property by which the size of arteries becomes adapted to that of the parts which they supply. The stream of blood, which at each pulsation of the heart passes through the wound into the vein, is so much taken from the supply intended for the nourishment of the limb. To compensate for the stream which passes through the wound in its coat, the main artery enlarges in the same manner as an artery becomes dilatated to supply a praeternatural growth."

Broca concluded that the lessened arterial pressure, which resulted from the deviation of blood through the fistula, called to the part a larger quantity of arterial blood, and he subscribed to the physiological teaching that the calibre of the vessel, other things being equal, places itself in harmony with the amount of blood which traverses it.

According to Bourges, the proximal artery loses its tone and resistance as a result of vasomotor change, while the thinning of its walls is a result of malnutrition due to some inherent change in the blood caused by the diminished pressure, on the basis that functional inertia may result in nutritive alterations.

The dilatation and thinning of the artery, according to Delbet, are to be explained on the basis of disuse atrophy, since the artery in the presence of the fistula needs no longer to contract against the customary arterial pressure.

Breschet explains the phenomena on the assumption that venous blood traverses the fistula and enters the artery during the period of cardiac diastole. Without placing any reliance on this hypothesis, it is well to note Franz's experimentally produced fistulae on dogs in which he ascertained that occasionally the venous pressure about the fistula may exceed that of the arterial.

It has been stated by some that the central dilatation of the artery varies directly in size with the duration of the fistula. In Gripat's brachial aneurism, with a duration of forty-two years, the subclavian artery had attained the volume of the abdominal aorta, there are, however, numerous instances of long duration in which the artery is little or not at all enlarged.

Delbet attaches some importance to the age of the patient, noting that in the cases of Adelman, Selenkow, Perry, Rokitansky, and Broca, the patients were more than forty years old.

What has been said concerning this fairly constant phenomenon, the proximal dilatation of the artery, perhaps justifies the collection of detailed descriptions of this feature, listed according to author and location. In the 447 cases in this series this characteristic was noted in 57 instances, giving a percentage total of 12.7.

ARTERIOVENOUS FISTULA

TABLE OF PROXIMAL DILATIONS

Author and Case No	Location of fistula	Duration of fistula and description of proximal dilation
Rokitansky (85)	Axillary	Duration of fistula, 33 years Proximal dilation of axillary artery
Osler (100)	Axillary	Duration of fistula, 30 years Proximal dilation of axillary artery in region between the thoraco acromial and internal mammary arteries
Hunter (140)	Brachial	Duration of fistula, 5 years Marked proximal dilation of brachial artery with visible pulsation Above bend of arm the artery makes remarkable serpentine turn which raises up the skin and resembles a beginning aneurism Artery at wrist much smaller than that on opposite side
Cleghorn (141)	Brachial	Duration of fistula, a few weeks Humeral artery seems considerably enlarged, and pulsation is visible from axilla to elbow
White (142)	Brachial	Duration of fistula, 10 years Brachial artery much enlarged proximally
Adelmann (147)	Brachial	Proximal dilation of brachial artery
Roux Obs 1 (156)	Brachial	Duration of fistula, 6 years Brachial artery above elbow attained considerable size, and its walls greatly thinned Over whole artery in upper arm to axilla, the artery was almost size of middle finger, with almost aneurismal dilation Size of arteries not sensibly larger than normal
Roux Obs 2 (157)	Brachial	Duration of fistula, 18 months Proximal dilation of brachial artery
Broca (167)	Brachial	Duration of fistula, 16 years During last few years artery dilated to extraordinary degree New aneurism, distinct from that on elbow, developed on brachial artery on middle of arm Axillary and brachial arteries so dilated could not be compressed Dilation of arterial system reached to innominate artery, because right common carotid artery was much more voluminous than left Axillary artery larger than aorta and walls very much thinned An arterial fusiform aneurism size of hen's egg was at point of amputation
Gripat (178)	Brachial	Duration of fistula, 45 years Strong pulsations of subclavian artery, which appears size of normal aorta Collapsed brachial artery measures 13 mm above sac, where it is very atheromatous, and 8 mm below, where it is flexible
Warren (205)	Hand	Arteries size of the carotids and so dilated as to form what might be called sinuses
Seger (225)	Femoral	Proximal dilation of femoral artery
Perry (226)	Femoral	Duration of fistula, 4 years External iliac arteries, especially the left, were extremely tortuous, being reflected upon themselves in a singular manner, during their course towards their crural arch, a condition which had, no doubt, given rise to impression of artery being very dilated, since it conveyed to hand simultaneously the combined pulsations of the folded portions Coats of femoral artery were no thicker than those of a vein, the attenuation having taken place equally in all its coats

TABLE OF PROXIMAL DILATIONS—*Continued*

Author and Case No	Location of fistula	Duration of fistula and description of proximal dilation
Horner (228)	Femoral	Duration of fistula, 4 months Artery had appearance of a dilation
Baker (229)	Femoral	Duration of fistula, 5 years Profunda artery greatly dilated distal to fistula Femoral artery normal
Pemberton (236)	Femoral	Right external iliac artery dilated, twisted and tortuous
Cordonnier Obs 2 (238)	Femoral	Duration of fistula, 23 years Artery slightly flexuous above aneurism, below its calibre was normal
Cordonnier Obs 3 (239)	Femoral	Duration of fistula, 15½ years Proximally one feels the femoral artery much larger than on the opposite side Moreover it is flexuous and forms a sort of italic "S"
Beaumont (241)	Femoral	Duration of fistula, 11 years On proximal side of aneurism, superficial femoral artery was greatly dilated, admitting two index fingers, on distal side, it was much contracted Common femoral and external iliac arteries on their whole course were equally dilated, but somewhat thinned and otherwise healthy External iliac arteries also greatly lengthened and thrown into a large curve
Brindejonc-Tréglode (242)	Femoral	Above tumor femoral artery seems to be very large but healthy Below, calibre is much smaller than in other leg
Hulke (248)	Femoral	Duration of fistula, 3 years Femoral artery dilated proximally
O'Grady (254)	Femoral	Duration of fistula, 15 years At operation femoral artery found to be as large as man's middle finger, and the coats thin and unhealthy External iliac artery resembles abdominal aorta in size Distended and tortuous, it resembled a sausage in size, with the appearance of a coil of small intestine
Banks (262)	Femoral	Duration of fistula, 6 years Artery above point of communication somewhat enlarged, and as it neared venous opening, increased in size and slightly sacculated, having a blind pocket which would hold a pea
Gallerand (263)	Femoral	Duration of fistula, 22 years Little below crural arcade on internal surface, is a well-marked dilation, about as large as a cherry, which constitutes a veritable aneurism by dilation Below tumor popliteal artery is diminished in calibre, and has undergone a sort of "des artériatization" Femoral artery just above fistula was not enlarged
Schwartz (267)	Femoral	Duration of fistula, 9½ months Examination of artery above tumor shows that artery is beginning to dilate
Davies-Colley (271)	Femoral	Duration of fistula, 5 years Diameter of artery at upper end of wound was about ⅝ inch Opposite to middle of incision it widened to almost an inch, and from being cylindrical above, it was here marked by a shallow longitudinal groove as if it were about to divide, but lower still became again cylindrical, and diameter was reduced to ½, or a little more In size and color resembled a congested piece of small intestine

ARTERIOVENOUS FISTULA

TABLE OF PROXIMAL DILATIONS—*Continued*

Author and Case No	Location of fistula	Duration of fistula and description of proximal dilation
Decamps (272)	Femoral	Duration of fistula, 16 years Femoral artery, thinned, is dilated to site of collateral on which sac is found Below the calibre is slightly diminished
Roberts (282)	Femoral	Duration of fistula, 6 years Femoral artery hypertrophied with small sac on it Common iliac and external iliac arteries on affected side twice as large as those on other side
Potherat (291)	Femoral	Duration of fistula, 7 years Artery presents at site of communication a sacciform dilation This part of artery is very thin Arterial trunk is dilated above and contracted below
Graves (308)	Femoral	Duration of fistula, 6 years Artery in upper part of Scarpa's triangle and for 2 inches above Poupart's ligament was thinned, dilated, sacculated, and evidently diseased
Osler (315)	Femoral	Femoral artery, is greatly dilated
Heuer (336)	Femoral	Duration of aneurism, 18 years Dilation of external iliac artery with artery above fistula size of index finger Thin-walled sac on artery Hypertrophy and dilation of heart with mitral insufficiency and auricular fibrillation
Halsted (367)	Femoral	Duration, 8 years Sacculaton on the artery opposite the communication Proximal dilatation of the femoral artery
Northern General Hospital (364)	Femoral	Duration of fistula, 16 days Common femoral artery was slightly dilated
Horsley Case 1 (368)	Femoral	Duration of fistula, several months Femoral artery was greatly dilated
Horsley Case 2 (369)	Femoral	Duration of fistula, a few weeks Artery was moderately dilated
Halsted (370)	Femoral	Duration of fistula, 12 years Marked dilation of femoral artery Appears as large as middle finger Dilation can be traced well up into common iliac artery
Brainard (374)	Popliteal	Duration of fistula, 5½ years Branches of popliteal artery were also enlarged as they opened into sac, 5 of them being large enough to admit a common silver catheter Coats of artery were thin like those of a vein
Cock (375)	Popliteal	Duration of fistula, 11 years It is not stated that the popliteal artery was larger than normal but it is said that the popliteal artery was larger going into sac than leaving it (The deep veins were so extensively thrombosed in this case that arterial blood pressure was probably not much lowered by fistula, and hence there was no dilation of artery) (W S Halsted)
McLean (378)	Popliteal	Duration of fistula, 19 years Clinically femoral artery appears much enlarged At operation popliteal artery was enormously enlarged Texture of arteries was so altered arteries looked and felt like veins

TABLE OF PROXIMAL DILATIONS—*Concluded*

Author and Case No	Location of fistula	Duration of fistula and description of proximal dilation
Fitzgerald (380)	Popliteal	Duration of fistula, 15 years Popliteal artery above aneurism somewhat dilated Neither profunda nor the anastomotic arteries had undergone any enlargement Femoral artery greatly dilated, but external and the common iliacs much more so, having a circumference 3 times that of the corresponding vessels on sound side Dilation ceased promptly at upper end of common iliac in a thin walled, prominent sacculus Elongation and tortuosity were not less prominent than the increase in diameter Internal iliac, profunda and the circumflex vessels all remained unenlarged Noteworthy that superficial femoral vessels were not nearly so dilated as common femoral and iliac vessels, but these are comparatively unsupported, while the former, at least in part of their course, are surrounded by fibre-muscular sheath
Keyes (381)	Popliteal	At autopsy popliteal artery was dilated and thinned
Lucas Championniere (383)	Popliteal	Duration of fistula, 23 years Femoral and external iliac arteries remarkably dilated
von Frisch (415)	Popliteal	Duration of fistula, 16 years Femoral artery widened and wall thinned Popliteal artery not enlarged
Halsted (390)	Popliteal	Definite proximal dilation
Da Costa (424)	Popliteal	Duration of fistula, 3 months The artery distal to point of fusion was small, and proximal to same point was much dilated, but not saccular
Gross (435)	Foot	Posterior tibial artery was nearly as large as femoral "Another interesting instance of proximal dilation of artery with naevus maternus with fistula, or fistulae" (W S Halsted)
Faguet (437)	Peroneal	Duration of fistula, 16 days Peroneal artery dilated above sac, and posterior tibial artery larger than normal
Parkman (62)	External carotid	Enlargement of the common and external carotid arteries
Fraser (74)	Temporal	Right occipital and temporal arteries greatly dilated
Laugier (81)	Posterior auricular artery	Auricular artery dilated both distally and proximally Probably is a cirroid aneurism
Bankhart (82)	Facial	Duration of fistula, 2 years and 5 months The facial artery above and below the jaw was remarkably tortuous and hypertrophied
Heuer (61)	Internal carotid	Internal carotid artery very tortuous
Halsted (68)	External carotid	Common carotid artery much larger than usual, but internal carotid artery smaller than normal

Condition of the Artery Distally—Unlike the proximal artery where dilatation occurs fairly constantly, that portion of the artery distal to the fistula is usually contracted to much less than its normal calibre The cause of this is the decreased quantity of blood traversing the vessel in

consequence of the loss of so large a portion diverted into the vein through the fistula

Among the rare instances of distal arterial dilatation may be mentioned the autopsies done by Breschet on the two femoral aneurisms, in which dilatation extended through the main trunks of the arteries into the capillaries. In the present series of cases, excluding those of Breschet, there were but three instances in which this distal dilatation was noted. In Cauchois' aneurism involving the popliteal, peroneal, and the anterior tibial arteries, there was marked distal dilatation of the anterior tibial artery, while in Baker's aneurism of the femoral vessels involving the profunda artery, this artery was markedly dilated and distended for the first two inches of its length.

Cardiac Complications—Morvan attributed to Boisseau the first intimation that a cardiac affection may complicate arteriovenous aneurism. In his fistula of the brachial vessels, palpitation of the heart was noted after the case was well advanced.

The most extreme and progressive myocardial insufficiency, occurring after arteriovenous aneurism, occurred in two of Halsted's cases of fistula of the femoral vessels. Up to the time of accident, the patients had suffered absolutely none of the discomforts of cardiac disease. After the formation of the fistula, however, they became thoroughly incapacitated and suffered at various intervals from symptoms of severe myocardial decompensation, and upon examination exhibited an enormous cardiac hypertrophy and dilatation, together with auricular fibrillation and evidences of chronic passive congestion.

The thickening of the inferior vena cava which occurred in Eisenbrey's fistula of eighteen years' duration leads one to consider whether this phenomenon, together with the cardiac hypertrophy and dilatation which accompanied it, might not presumably be the result of increased venous pressure exerted over a long period of years.

One of the most conclusive instances of myocardial insufficiency occurred in Stewart's patient with femoral arteriovenous aneurism in whom, one month following the establishing of the fistula, a systolic murmur was made out over the heart, together with an enlargement of the cardiac outline. A short time after the lateral suture of the artery and vein the heart diminished considerably in size and the murmur disappeared.

Cardiac hypertrophy and dilatation were present in Fitzgerald's popliteal fistula, in Osler's and in Rokitsansky's axillary arteriovenous aneurisms, and in Horsley's and in Baker's femoral fistulæ.

Bernard Cunéo, in a recent paper, published an instructive series of venous pressure readings from a case of femoral arteriovenous aneurism. He found that the venous pressure, measured in terms of centimetres of water, was increased not only about the fistula, but in the corresponding vein of the opposite extremity and in one of the veins of the upper ex-

tremity as well. Such a general venous hypertension Delbet considered the causative factor in the production of the marked cardiac hypertrophy and dilatation with accompanying symptoms of decompensation which occurred in a case he recently observed. Toussaint also reported two patients with arteriovenous fistulæ who exhibited similar cardiac phenomena.

V SYMPTOMATOLOGY

Murmur—The murmur of arteriovenous fistula is continuous in character, reinforced in intensification with each heart systole, and is propagated in the main in a central direction along the vein, becoming increasingly faint as one recedes or proceeds from the communication. It is heard with maximum intensity immediately over the communication, a circumstance which is a valuable indication as to the exact site of the fistula.

Broca and Henry agreed that the cause of the murmur lay in the vibration of the communication when its borders were set into motion by the continuous passage of arterial blood.

Burckhardt, as well as Billroth, thought that it was caused by the clashing of the venous and arterial columns of blood flowing in opposite directions. Chassaignac attributed to the sound a chemical origin resulting from the mixing of the venous and arterial blood, and Hodgson and Richerand based its occurrence on the friction of the blood on the walls of the communication.

The experiments of Chauveau, Weber, and von Wahl confirmed the speculation of Scarpa in demonstrating conclusively that it, like all vascular murmurs, is of the fluid type, for whose occurrence conditions are here particularly favorable where blood under a certain pressure from the artery flows into a widely expanded vein.

The individuality of this murmur has called forth descriptions from a large number of writers. Bayer compared it to the forcing of air through a syringe, while to Larrey it had the sound of water streaming through metal tubes. Willaume compared it to the noise of a bellows, while to Seeger it seemed like water rushing over a dam and like the whistling of the wind. Ribes likened it to the noise of a mill race. The French call it *bruit cataire* and *bruit de souffle à double courant*, while to the Germans it is the *schwirrendes Gerausch*. Burgess describes it as of the sound of a fly in a paper box.

A peculiarity of this murmur is its occasional audibility at a distance without ear contact. In Murphy's and Graves' femoral and Osler's axillary aneurisms it was distinctly heard with the ear six inches away from the affected part.

Thrill—The rough purring thrill is an evidence that the whirling eddies of blood transmit their vibrations to the thin walls of the vessels, like the murmur it is continuous in character, and has a maximum

systolic accentuation directly over the fistula, with a gradually diminishing intensity as one leaves the point of communication. It must be remembered that the bruit and thrill are only different aspects of the same phenomenon, translated into the medical tongue according to the sense which perceives it. Hunter characterized the thrill as simulating the forcing of water through a narrow opening or the continued whisper of the letter "R". It is the *frémissement vibratoire* of the French.

Cleghorn first placed one end of a metal sound between the teeth and held the other over the tumor and thus combined the palpatory and auditory sensations of the thrill. It was seen experimentally that the thrill spreads through the neighboring vessels with varying intensity and is more strongly felt in the central than in the peripheral segment of the vein.

Venous Pulsation—Venous pulsation occurs when the arterial pulse wave is transmitted to the venous column of blood and is propagated both peripherally and centrally, together with the murmur and the thrill. From what has been previously said regarding the exclusive anatomic relations of the long saphenous vein, this venous pulsation is not found on a superficial aspect of the lower extremity when the deep veins of the thigh are involved. Franz, in experimentally produced fistulæ in dogs, noted that the venous pulsation was visible for but a few centimetres in a central direction, but that it could be seen peripherally a great distance from the communication.

Pressure Conditions about the Fistula—Much light has been thrown on the question of the intravascular tension about the fistula by Ney's experimentally produced aneurisms in dogs. His purpose was to emphasize the great importance attached to the central segment of the vein in side-tracking and hurrying away to the heart the arterial blood destined for the peripheral artery and the nourishment of the limb. He observed that the arterial pressure under normal conditions varied between 111 and 115 mm of Hg, but found that after the formation of the fistula, the pressures in the proximal and distal segments of the artery were equal, varying between 73 and 107 mm of Hg. The venous pressure he found normally to be between 9 and 11 mm of Hg, while, with the fistula in operation it showed an average pressure both centrally and distally, between 71 and 105 mm of Hg, thus establishing a pressure on the venous side but little less than that on the arterial.

Without entering into confusing details one can say that Franz has proved the existence of four different streams of blood flowing through the fistula, the first, running from the peripheral segment of the artery into the central segment of the vein, the second, from the central part of the artery into the central part of the vein, the third, from the central division of the artery to the distal segment of the vein, and the fourth, from the central part of the artery to the peripheral part of the vein. Bra-

mann's observation of a venous pressure reading of 87 mm of Hg in his aneurism of the axillary vessels is the only evidence of the correlation between animal experiments and fistula in the human

Phenomena Associated with Venous Obstruction—A variety of nutritive and other changes is furnished by the obstruction to venous return. The œdematous infiltration and hypertrophy of the extremity in one of the femoral aneurisms of Lannelongue showed a difference in the circumference of the two thighs of 35 centimetres. There occurred an extraordinary degree of œdematous infiltration with the occlusion of the central segment of the vein in the fistulæ of von Wahl in the femoral vessels, of Simon in the abdominal aorta and inferior vena cava, and of Leflaive in the common iliac vessels. According to Matas, œdematous infiltration and hypertrophy of the subcutaneous connective tissue are followed by the subsequent atrophy of the skin, with histologic changes akin to those which accompany varicose vein, while the skeletal muscles undergo atrophy and degeneration.

In the lower extremity, trophic disturbances have occurred in almost all the cases which have been followed a sufficient length of time. Large and painful ulcers were the points of refractory hemorrhages leading eventually to death in Leflaive's case of fistula of the common iliac vessels, while in the femoral aneurisms of Hulke and Billroth, ulceration developed in the course of four years. Absolute incapacity from atrophy and ulceration of the affected member resulted in the femoral aneurisms of Brindejonc-Treglode.

Spontaneous gangrene of the foot and leg occurred within eight hours of injury in LaGrange's popliteal aneurism, and, although not common, has occurred even after long periods, as was evidenced by the partial gangrene of the hand which took place after forty-two years in Gripat's brachial aneurism.

Hypertrophy of the hair and nails on the affected part has been noted.

Bone and Calcium Deposits in the Vicinity of the Fistula—Among the most interesting nutritional disturbances associated with arteriovenous aneurism is the effect of such a fistula on bony growth in the vicinity. In certain cases of femoral aneurism, increased length of bones has been noted. In 1854 Giralde observed in a grown man an arteriovenous aneurism of fourteen years' duration, caused by a stab wound in the thigh, sustained in childhood. Careful examination revealed an increase of 3 centimetres in length of the affected leg which was explained on the hypothesis of *over-development* due to obstructed venous return, one-third of the increase being attributed to the femur, and the other two-thirds to the tibia, the foot being elongated half a centimetre.

This subject has been commented upon from time to time by later writers, notably Cordonnier. He first stressed the fact that in Giraldès' case, as in an identical one of his own, the injuries causing the fistula

were received during adolescence, or the period of life of growing bone. Other instances of the same phenomenon have been recorded. Gwilym Davis mentions a young boy with a femoral fistula produced several years before by an accidental wound of the thigh, during an operation for circumcision. This case was brought to him on account of the marked difference in length between the well and the affected leg. As a result of this and similar instances, he questions whether the production of a fistula might not be a desirable means of increasing the length of limbs in certain cases of shortening due to hip disease and other disabilities.

Sir Prescott Hewett reported a congenital varix of the common iliac vessels in a seventeen-year-old patient, in whom it was perceived that the affected leg was 2 inches longer than its mate. Franz described a case with femoral fistula in which the nutritional changes caused an increase in the length of the member, and remarked that the stimulus exerted on the epiphysial lines is similar to that exerted in young subjects with osteomyelitic changes during the period of growth.

Concomitant Nerve Injuries—In the regions of the axillary and the subclavian vessels the nerves in the vicinity are particularly liable to injury at the time of the formation of the fistula. In this series of cases nerve injuries were by far most frequent in aneurisms of the subclavian vessels, as, for example, in the cases of Larrey, Wederstrandt, Veiel, Erdmann, Matas, and Pluyette and Bruneau. In the axillary aneurisms they were present in the cases of Bramann, Durmin, and Quénu.

Changes in Surface Temperature—Faguet and Franz, in femoral fistulæ, noted an increase in the surface temperature immediately over and about the site of the fistula, while Knaak and Bardeleben in axillary aneurism, and Henry in a femoral aneurism, found the surface temperature of those parts peripheral to the fistula decreased. Trélat and Faguet, in aneurisms of the femoral vessels, found the skin temperature elevated at the level of the fistula and decreased below it. The findings of these groups of men were reconciled by Franz's experimental studies which showed an increase in temperature about the fistula, caused by the increased collateral compensation, and a decrease in those parts peripheral to the communication, as a result of the venous stasis.

In general, however, patients complain of a sense of chilliness and cold in the part at or below the region of the aneurism.

Sphygmographic Tracings about the Fistula—Sphygmographic tracings of the venous pulsation have at different times been recorded. Ebenau, in 1883, and Franz, in 1905, both working with aneurisms of the femoral vessels, took tracings of the pulsation in the femoral vein in which was found a definite *anacrotism* with the temperature well up on a broad summit. This anacrotism was interpreted by Marey as the effect of the arterial blood on the peripheral segment of the vein, and the broad summit was explained on the supposition that the blood streaming into

the vein requires a longer time to stretch its flabby walls to their fullest dilatation. In varicose aneurisms the phenomena may be the expression of the effect of the arterial blood on the walls of the sac.

Cerebral Vascular and Neurologic Disturbances—Weakness, dizziness, and headache are often associated with fistula of the large vessels of the neck. In Stimson's and Willaume's aneurisms in this region there were marked hearing and visual disturbances, while in Joret's aneurism of the internal carotid artery and the internal jugular vein there occurred a complete paralysis of the right side of the body, with death from epilepsy thirty months later.

Diminished Peripheral Pulsations—In various cases with diminished peripheral pulsations sphygmographic tracings were made over the peripheral segment of the artery which showed what has been interpreted as a diminished arterial flow.

Tardy Appearance of Signs—A study of this series of cases establishes the fact that in many instances symptoms and signs either appear late or have not been recognized early. One of the commonest causes for the tardy development of signs is the temporary thrombosis of the vascular wounds. The thrombus may later become dislodged from increased activity or manipulation of the part. With the dislodgement of the thrombus the fistula becomes patent and the intervascular circulation is restored.

In Cooper's aneurism of the femoral vessels the signs made their appearance on the fifth day, while in Robert's femoral aneurism they were delayed six weeks. In Legouest's axillary aneurism signs occurred in eight days, and in Bardeleben's axillary aneurism no signs appeared until after two and a half weeks. In the aneurisms of the subclavian vessels the signs on the average were noted after about six days. The recording of the varying times of the appearance of signs suggests a lack of uniformity in their observation.

Symptoms Induced by Proximal Compression of the Artery—Some observers in their careful analyses have noted a peculiar set of circulatory phenomena dependent upon proximal compression of the artery. The most mysterious feature in this connection occurred in Branham's aneurism of the femoral vessels, in which case proximal compression of the common femoral artery slowed the heart so markedly as to cause its rate to drop from eighty to thirty-five beats a minute, and so to remain until the pressure was released. Compression on the artery on the sound side produced no such effect, while the examination of the heart showed it to be free from any valvular trouble. Associated with the slowing of the heart beat, dizziness, dyspnoea, and distress were noted. Compression of the proximal femoral artery in Hugnier's aneurism caused syncope, while in Schwartz's aneurism it produced agitation, cyanosis, and intense dyspnoea, all of which disappeared with the cessation of pressure. Pres-

sure on a carotid artery in Beach's patient with temporal aneurism produced sensations of dizziness and distress, while slight compression over the subclavian artery in Breschet's aneurism in that region caused a feeling of discomfort about the right side of the head and in the right eye. Pressure over the tumor in Cordonnier's and Henry's femoral aneurisms elicited a pain in the heart.

Initial and Secondary Hemorrhage—Although the initial hemorrhage occurring in Rotter's subclavian and in Halsted's and Horner's femoral aneurisms resulted in syncope, the bleeding in most instances ceased spontaneously or as a result of light compression.

The most important factor in its spontaneous arrest is the infiltration by the extravasated blood of the muscular sheaths immediately around the wound canal, leading to its obliteration. Moreover, where severe primary hemorrhage has occurred with the consequent fall in blood pressure, clot formation is favored both at the point of vascular injury and at the wound's external orifice.

When the secondary hemorrhage occurs during the first week after injury it is rarely of any importance, for it is usually little more than leakage from a small wound during the early contraction of the hæmatoma. When there is, however, a rapid extension of the swelling, one must suspect that type of secondary hemorrhage that probably depends upon the defective process of localization which has allowed some part of the limiting boundary of the false sac to give way. A sudden rise in blood pressure, accompanying increased activity, or perhaps the free movement of the limb, may be its cause (Makins).

Secondary Arteriovenous Aneurism—A special study of the aneurisms arising from the regions of the sinuses of Valsalva, in the pericardial portion of the aorta, is worth while because of the effect they produce on the neighboring organs. They compress, obliterate, and even form communications with the large venous trunks with which the aorta is surrounded, and thus constitute secondary arteriovenous aneurisms of an extraordinary character. They even burrow into the musculature of the heart itself and have ruptured into the right ventricle, right auricle, and pulmonary artery.

We find an occasional example of rupture from some unusual effort or exertion, but these communications have usually resulted from a gradual softening or ulceration of the walls of the sac. The clinical picture is characterized by a sensation of something giving way in the chest, a feeling of faintness, dyspnoea, and palpitation of the heart, and very decided signs of obstruction to the venous circulation. The face is usually livid and bloated, there is widespread œdema of the tissues in all the cases in which death does not supervene too rapidly, and the anasarca involves all parts of the body whose veins are distal to the communication. If the aneurism of the ascending aorta be in communication with the

superior vena cava, the œdema of the face and arms stands in remarkable contrast to the normal appearance of the lower half of the body. When, on the other hand, the abdominal aorta and the inferior vena cava are the seat of the fistulous communication, the œdema of the legs and the lower half of the body is in marked contrast with the unswollen condition of the arms. When the aneurism erodes the appendix of the right auricle, the right ventricle, or the pulmonary artery, the venous system of the whole body distal to the orifice of the communication shows the condition of general anasarca.

VI DIAGNOSIS

In this period of modern destructive warfare with the inevitably large numbers of concealed vascular wounds, a careful search should be made for all possible pathological intervascular communications, of great aid in recognizing them is the carefully ascertained history of injury over the vascular tracks.

The cardinal symptoms are a loud, continuous, reinforced murmur with a central and peripheral propagation, a purring, reinforced thrill, and definite venous dilatation and pulsation at the site of injury. When these are present the diagnosis of arteriovenous aneurism should present no difficulties.

Differential Diagnosis as to Variety—According to Francke, the aneurismal varix appears about three or four days after the injury in the form of a soft, fluctuant tumor, oval in shape, and usually about the size of a hazelnut, increasing very gradually in size, and which may be obliterated with light pressure.

The varicose encysted type of tumor is harder, firmer, and less fluctuating, and although made smaller by pressure, it will not altogether vanish. It is irregular in form and its size varies within wide limits, it is not enlarged by the compression of the artery above, or diminished with the elevation of the member.

The varicose aneurism by dilatation may be differentiated by the fact that the tumor is less prominent, fusiform in shape, soft to the touch, completely disappears on direct compression, and is diminished in size by the elevation of the part.

Differential Diagnosis from other Conditions—From arterial aneurism the arteriovenous aneurism may be readily distinguished. In the arterial aneurism the murmur is not constant, but when present is systolic in time and therefore intermittent.

In cirroid aneurism the thrill may be absent or barely palpable, while the afferent and the efferent arteries, together with their branches, are all enlarged and tortuous. The murmur, if present, is weak, lacking the systolic accentuation, and pressure above the aneurism will not cause the murmur or pulsation to vanish. Its general location is about the head,

face, and neck, and in vessels of smaller calibre than those in which arteriovenous aneurisms occur. It is always of spontaneous origin and frequently occurs in association with nævi.

VII PROGNOSIS

Observers from the time of Hunter until the present have expressed varying opinions as to the prognosis in this affection. The consensus of opinion is that the condition is always embarrassing, often incapacitating, and occasionally leads to serious results.

Prognosis According to Variety—Some writers have differentiated the severity of the prognosis in accordance with the variety of the aneurism. According to Scarpa, the aneurismal varix can be borne with impunity if it be not subjected to frequent violent and unusual efforts, whereas the varicose aneurism tends to enlarge and cause pressure disturbances. Many of the later authors, Bayer, Cooper, Nelaton, Richet, Bardeleben, and others have accepted Scarpa's analysis of the prognosis according to variety.

According to Delbet, however, Scarpa meant by his varicose variety only that type of fistula in which the false sac lies between the artery and the vein, namely, in the type known as the *intermediate encysted varicose aneurism*. The authors mentioned above, however, gave a bad prognosis in all aneurisms possessing any circumscribed dilatation on the artery, the vein, or the channel of communication. In view of the fact that most cases of simple aneurismal varix sooner or later show saccular dilatation, it is difficult to see how a clean-cut differentiation between these two main varieties may be made.

Francke, Delbet, and Bramann considered the dangers caused by the varix to be as great as those belonging to the varicose type.

Prognosis as to Duration—The prognosis must be modified by the knowledge that the presence of fistula is not incompatible with long life. Among the cases in which the condition has existed for periods exceeding twenty-five years are the following: Schottin's aneurism of the vessels of the wrist was present for fifty-five years, Gripat's brachial aneurism lasted forty-two years, Moore's aneurism of the temporal vessels was present for thirty-six years, Hunter's brachial aneurism for thirty-four years, Gallerand's femoral aneurism lasted thirty-two years, Heuer's femoral aneurism was present twenty-eight years, and Queitel's common carotid aneurism for twenty-seven years.

Prognosis as to Progressive Danger—It must be borne in mind that there is a potential progressive danger from enlargement and rupture of the tumor. Sale's aneurism of the internal carotid artery and the internal jugular vein resulted in a hemorrhage and death in eight months after a long period of threatened rupture. After a remission of sixteen years a sudden enlargement resulted in gangrene which caused the death of

Broca's patient with brachial aneurism Rokitsansky's axillary aneurism remained stationary thirty-three years, after which it suddenly enlarged and necessitated operation, while Gripat's aneurism of the brachial vessels after a duration of forty-two years developed a sudden enlargement causing gangrene of the fingers Annandale's aneurism grew to the size of an infant's head in the short period of three months, and an enormous tumor was present within four weeks after injury in Czerny's femoral aneurism The brachial aneurism in Park's case enlarged to the size of a fist and finally ruptured

Gerdy and Broca have insisted on a more serious prognosis with aneurisms of the lower extremity

VIII TREATMENT

Non-operative—The development of the treatment of arteriovenous aneurism from Guattini, in 1785, up to the present date is one of gradual progression The earlier years were not the years of surgery and the physician's armamentarium was limited to therapeusis, manipulation, and pseudo-operative procedures

Injection of Coagulating Fluid—The knowledge that certain chemicals possessed blood coagulating qualities, and the hope that a coagulum resulting from their use would block off the fistula, led to the injection into the sac of the aneurism of perchloride of iron Failure attended its first use in Velpeau's brachial aneurism, and death followed in Pravatz's brachial aneurism, in which its use rendered amputation necessary Although two injections of this chemical cured Jobert's aneurism, the dangers from gangrene and secondary hemorrhage do not warrant its employment in this type of case

Galvano-puncture—Cures following galvano-puncture may in most instances be attributed either to the compression which has preceded or the inflammation which has followed its application The consequent gangrene from detached emboli and severe hemorrhages and infections, coupled with its rare cures, make its use in the treatment of arteriovenous aneurism entirely unjustifiable

Medicinal Treatment—Possibly the earliest therapy was the application to arteriovenous aneurism of Valsalva's precepts in arterial aneurism This treatment consisted in repeated venesection and purgation, in conjunction with digitalis therapy and scanty diet, in the hope that spontaneous coagulation of blood about the fistula might take place Such treatment brought no satisfactory results

Indirect Compression—Of the bloodless methods of treatment the varieties of compression, both direct and indirect, have been most extensively and successfully employed *Indirect compression* is that which is exerted upon the afferent artery and not over the aneurismal tumor, and

has for its purpose the spontaneous coagulation of blood in the aneurismal sac. Of the different forms of compression, it is the least painful and may be the longest continued without interruption. According as the pulsation of the tumor is diminished or made to disappear altogether, the compression is termed partial or total.

Direct Compression—In instituting direct compression of the *instrumental* variety, a tampon is securely bound immediately over the orifice of the communication. The intolerable pain and the occasional accidents from trophic disturbances, together with its unreliability, are the main objections to this method.

The adoption of the *digital* variety of direct compression is attributed to Vanzetti, of Padua, who cured several brachial aneurisms by this method of prolonged pressure with the tip of the finger immediately over the tumor as near the communication as possible. The treatment was instituted as a means of stimulating collateral circulation in preparation for a future ligation, but it should be remembered that cures have been obtained in but a few brachial aneurisms of very recent origin, and that in some instances it has exposed the tumor to inflammation and rupture with a subsequent gangrene of the part.

In this series of cases compression was attempted in all locations and varieties of aneurisms in 61 instances, 9 patients were cured, 3 died, and in the remainder the procedures were failures. Of the cures 7 occurred in brachial aneurisms, 1 in Trélat's femoral aneurism, and 1 in Geschwind's axillary aneurism.

Guattini, in 1785, using a combination of the direct and indirect methods of compression, has to his credit the first cure of brachial aneurism. Other cures are attributed to Vanzetti, Monteggia, and Brambilla.

Considerable interest has arisen regarding the possibility of transforming arteriovenous aneurism into arterial aneurism by the obliteration of the communicating fistula. In 1809 Scarpa conceived the idea of obliterating the point of communication between the two vessels, for he wrote "In a favorable case in which the exact opening in the vessels may be brought into union against the bony walls, and the pressure here maintained for a sufficient length of time, there is no reason to suppose that the firm mass of the adhesive tissue will not seal off the opening with the resulting cure of the patient." Brown, in 1836, thought that "a gradual, prudent compression in young subjects may bring about an adhesive inflammation which will determine the obliteration of the opening between the artery and the vein." Nelaton, in 1846, first accomplished this result.

Inflammation of the sac is the most common accident resulting from compression. In Spence's case of femoral aneurism it necessitated operation, and in Carafi's femoral fistula compression on the communication was followed by gangrene. Death following compression was the out-

come in Gallerand's femoral aneurism, while compression of the abdominal aorta and inferior vena cava in Simon's aneurism caused peritonitis from intestinal gangrene

Operative Treatment—Hunterian Ligation—Hunterian ligation, or the proximal ligation of the artery at a distance from the fistula, was practiced in 32 cases in this series, resulting in 5 cures (15·6 per cent), 19 deaths (59·3 per cent), and 8 instances of gangrene (25 per cent). Recurrence constituted the majority of the failures. Three cures of femoral aneurism were reported by Korlowski and Bickham after ligation of the external iliac artery, and by Freyer after ligation of the common femoral artery. A cure resulted in Stromeier's popliteal aneurism.

Deaths from hemorrhage or infection occurred in the femoral aneurisms of Gayet, Lannelongue, Paguet, and Perry, in the brachial aneurisms of Schuh and Piragoff, and in the axillary aneurism of Rokitsansky. Death from gangrene and infection occurred in Socin's and Graves' femoral aneurisms. Deaths from hemiplegia are noted in Prince's aneurism of the common carotid artery and the internal jugular vein, and Holston's aneurism of the carotid artery and the external jugular vein. Gangrene caused death in Fitzgerald's aneurism of the popliteal vessels, and in Robert's femoral aneurism. Death followed the ligation of the external or common iliac arteries in the aneurisms reported by the following men: Venturoli, Gayet, Roberts, O'Grady, Hutchinson, Lannelongue, Graves, and Faguet. In Bramann's table of 31 Hunterian ligations, only 6 were successful, or 19·3 per cent. There were 8 cases of gangrene, or 25·8 per cent.

Delbet reported 40 cases treated by proximal ligation, among which there were 10 cures, or 25 per cent, 9 deaths from gangrene, or 22·5 per cent.

Bardeleben has the following to say about gangrene: "If we could by means of asepsis guard against wound infection and inflammation, we should still be unable to regulate the collateral circulation."

According to Matas, there are the following disadvantages to Hunterian ligation:

A. *The liability of gangrene of the limb is increased by* (1) the interposition of two obstacles to the path of the blood from the cardiac side to the periphery, first at the seat of ligature and secondly at the site of the aneurism, which is totally or partially blocked off by clots after the ligation, (2) by putting out of function a large number of important and often essential collateral branches, given off from the main trunk between the ligation and the aneurism, in some cases the track of the artery being obstructed by a thrombus for a great part of its length after the ligation, (3) in consequence the blood has to pass through two sets of collaterals before it can reach the part beyond the sac, (4) the risk of gangrene, therefore, increases in direct ratio to the distance between the ligation and the sac, (5) the risk of obstruction of the distal end of the artery by emboli, or propagated thrombi, is greatest in Hunterian ligature, which aims at the gradual and not the immediate suppression of the circulation of the sac, the minor circulation in the sac resulting from previous collaterals which empty into the main trunk above.

the sac favoring the increased deposition of active clot, and also breaking up the new, soft and passive clot formed temporarily by the ligation of the main trunk

B *The reestablishment of the collateral circulation* after ligation at a distance may carry more blood into the main artery between the ligature and the sac, and thus lead to recurrence

C *There is no advantage in ligating the artery at a distance*, because (1) the simple aseptic ligature strengthens the artery at the seat of ligation, and there is no secondary hemorrhage when there is no suppuration, (2) it has been shown that the arteries are often quite healthy immediately above the aneurism (especially in the traumatic cases)

D *The danger of infecting the sac* by the manipulations required to ligate the artery at its termination in the sac is not to be considered in aseptic operations

Ligation of Arteries—Scarpa was the first to advise the proximal ligation of the artery in the immediate vicinity of the sac as an improvement over the Hunterian ligation. Its advantages are that it shuts off the circulation at once and allows the fluid contents of the sac to drain away completely, allowing whatever laminated clot is present to remain. The volume of the sac is diminished and the tendency is less for the passive clot to break up (Matas)

In 16 cases of ligation of this type there were 7 cures, or 43·7 per cent, 4 deaths, or 25 per cent, and 3 cases of gangrene, or 18·7 per cent. Death from gangrene occurred in Horner's and Bloch's femoral aneurisms, and gangrene in Lewtas' case demanded amputation

Double Arterial Ligation—Proximal and distal ligation of the artery in the immediate vicinity of the sac, better known as double arterial ligation, was first successfully employed by Norris in 1843. Malgaigne, in 1852, and Dupuytren before him, approved the operation. It has been performed thirty times in this series, with 17 cures, or 56·6 per cent, 3 deaths, or 10 per cent, and 3 instances of gangrene, or 10 per cent

Hemorrhage and infection were the cause of death in Page's and Cooper's femoral aneurisms, and death followed amputation for gangrene in Joyce's femoral fistula. According to Broca, the operation will be successful if the strip of artery between the ligatures contains no collateral branches

Quadruple Ligation—Proximal and distal ligation of both artery and vein, or quadruple ligation, has been practiced in 27 cases, from which there resulted 21 cures, or 77·7 per cent, 2 deaths, or 7·4 per cent, and 4 instances of gangrene, or 14·8 per cent. Death from gangrene occurred in Pieri's femoral and in McLean's popliteal aneurisms. Amputation and recovery followed gangrene in Eccles' and Duval's aneurisms of the femoral vessels

Incision of the Sac—When the operation of Antyllus, or the incision of the sac, is performed, the afferent and the efferent vessels are first ligated securely outside the sac, which is then incised and its contents evacuated, and a search made for any entering collaterals. If such are

found, they are ligated on the periphery of the sac and the cavity is packed

In 16 cases of this variety there were 8 cures, or 50 per cent, 5 deaths, or 31·2 per cent, and 3 cases of gangrene, or 18·7 per cent

While some claim the two advantages of incision of the sac to be the ability to empty the sac of clots and the increased facility for search of the collateral vessels, Delbet considers these advantages of little moment, because clots in the sac are rare, and because the search for the collaterals is really not facilitated. Among the chief objections to the method are the astounding secondary hemorrhages which may result from collaterals so small as to be unsuspected during the operation, and the delayed wound closure from the abandoned sac. Moreover, the calcareous plates, which so often line the sac, act as foreign bodies and interfere by their pressure with the perivascular nutrition, while the danger from disseminated emboli always remains

Extirpation—The operation of the complete extirpation of the aneurism after quadruple ligation of the afferent and efferent vessels, with its high percentage of favorable results, must be duly accredited (Fig 11). In 122 such operations there had been 117 cures, or 95·9 per cent, 1 death, or 0·8 per cent, and 1 residual gangrene, or 0·8 per cent. Death occurred in Barendrecht's case in the popliteal vessels, and failure resulted in Jaboulay's case of posterior tibial aneurism. Among the cases of improvement may be mentioned the popliteal aneurism operated upon by von Eiselsberg, in which there were residual plaques of gangrene of the foot, and Bornhaupt's aneurism of the popliteal vessels with residual motor and sensory changes, and von Eiselsberg's brachial aneurism, which showed symptoms present after three years. In this type of operation the disadvantages of tardy healing and imperfect hæmostasis, as well as gangrene from pressure on arterial collaterals, which in other operations are so major, are here reduced to a minimum. By careful dissection one may obviate the useless section of adherent nerves and vessels, whose loss plays so important a rôle in the formation of residual nerve and trophic disturbances. In general, it fulfills all the requirements, presents the least danger, and has given up to the present the best results

Conserving Operations—Most writers agree that the ideal operation is that which maintains the continuity of the vascular paths, and the procedures which serve this purpose are here described under the caption *conserving operations*. The continuity of one or both vessels may be maintained by three methods, ligation of the communication, lateral suture, and end-to-end suture

1 *Ligation of the canal of communication* is possible only in cases where the communication is short and easy of access (Fig 12). It has been successfully performed by Cranwell in a popliteal aneurism, and by Weigel in a brachial aneurism. Delbet was successful in ligating the communication, but the resulting arterial varix necessitated extirpation

ARTERIOVENOUS FISTULA

Ligation of the communication with a double ligation of the vein was done in the two brachial aneurisms of Van Ischmoot, and Boddaert and Vercauteren. Ligation of the communication with a double ligation of the artery was successful in Westergaard's femoral aneurism and in Erdmann's subclavian aneurism. This operation was successfully performed by Berkeley and Bonney in an aneurism of the subclavian vessels, until hemorrhage, which followed suppuration from the replacement of the resected clavicle, necessitated ligation of the innominate artery.

2 Up to 1917, exclusive of war statistics, *lateral suture of the artery and vein* has been attempted in 10 cases, resulting in 8 cures and 2 deaths. The cures are attributed to Veau in aneurism of the axillary vessels, Wiessinger and Korte in popliteal fistulæ, and to Ray in an aneurism of the anterior tibial vessels. Cures in aneurisms of the femoral region are claimed in the cases of Gessner, Stewart, and Halsted. The femoral fistula, located in Hunter's canal, operated upon by Doctor Halsted, was of particular interest. Together with the characteristic symptoms of arteriovenous aneurism there were exhibited marked swelling of the affected leg and the presence of many healed ulcers. The treatment consisted of lateral suture of the artery and the vein. Heuer successfully sutured the femoral artery and vein in a femoral aneurism, but was unfortunate enough to lose his patient on the forty-fourth day from empyema complicating pneumonia, contracted in the hospital. Hemorrhage followed Horsley's double lateral ligature of the femoral vessels, for which a ligation of the external iliac artery was later done, the patient, however, dying from an acute myocardial decompensation.

Lateral suture of the artery and double ligation of the vein has been done in three cases. Zoege von Manteuffel, in removing an ossified femoral aneurism intimately connected with the femur, sewed two rents made in the artery and one in the vein, after which the vein and the tumor were resected. Garrè in a femoral aneurism and Doyen in a brachial aneurism doubly ligated and resected the vein with the tumor attached after the lateral suture of the artery. Lateral suture of the vein with double ligation of the artery was successful in Montaz's femoral, Matas' subclavian aneurisms, and in Newbolt's popliteal aneurism. In Greiss's femoral aneurism, a double arterial ligation and resection was performed and the segment was used to reinforce the lateral suture of the vein. Improvement resulted from this treatment in Halsted's femoral aneurism. The one failure occurred in Auvray's ligation of the communication, following a lateral suture of the artery.

End-to-end suture of the artery with the resection of the vein was accomplished by Garrè in a popliteal aneurism, while end-to-end suture of the artery and lateral suture of the vein was accomplished by Murphy. Godwin performed an end-to-end suture of the vein and a lateral suture of the artery, which latter he reinforced with a segment of transplanted

internal saphenous vein (Fig 13) Da Costa, in an aneurism of the popliteal vessels, made a lateral suture of the artery and an end-to-end suture of the resected vein, reinforcing the lateral suture with the segment of the resected vein (Fig 14)

Preliminary Test of the Collateral Circulation—The Korotkow blood-pressure test for determining the efficiency of the collateral circulation consists in compressing proximally the artery leading to the aneurism, and while maintaining this pressure, estimating the blood-pressure in the peripheral circulation, such as the finger The height of the blood-pressure thus found in the peripheral arterial segment furnishes the true indication as to the adequacy of the collateral circulation Thus it may be determined whether an obliterative operation may be undertaken

The advantages and disadvantages of Korotkow's test are aptly illustrated in the axillary fistula of von Oppel When he compressed the axillary artery in this case immediately above the aneurism, the blood-pressure reading in the peripheral artery was 40 mm of Hg A prognosis of a sufficient collateral circulation was therefore made, and an operation undertaken It may be said that, near the tumor, two brachial veins opened into a much dilated axillary vein

In the first operation, after the axillary artery was divided proximally, the blood-pressure in the finger was found to be zero and the limb became pale Considering the collateral circulation adequate, however, the wound was closed, but the peripheral pressure did not return and the forearm and hand blanched It was then thought that the arterial blood had returned to the heart by way of the before-mentioned superficial axillary vein

In a second operation this vein was ligated both distally and proximally, but the blood-pressure in the finger still remained at zero It was certain, then, that some deep accessory vein carried the blood to the heart, for when compression was made in the wound between the stumps of the divided artery, the arm became red and the pressure in the fingers rose to 40 mm of Hg It was concluded, then, that some deep vein in the neighborhood of the artery had also been obliterated by the digital pressure, and that this vein was the one carrying the collateral blood back to the heart Further search revealed such a deep vein which von Oppel now ligated and divided centrally The pressure in the fingers then returned to 40 mm of Hg Following the removal of the bandage, however, the hand again paled and the blood-pressure dropped to zero, a phenomenon which can only be accounted for by the widening of the collateral paths

Since the collateral paths had widened and diverted the arterial blood to the heart, a third operation was performed on the same day and the sac was excised entire, with the resulting cure of the aneurism

ARTERIOVENOUS FISTULA

IX EXPERIMENTAL ARTERIOVENOUS ANEURISM

Amussat, in 1843, was the pioneer in the field of experimental arterio-venous anastomosis, and he produced in horses several varieties of varicose aneurisms. No further experiments on the subject were made, until, in 1878, Francois Franck studied its production from the standpoint of practical application to the clinical course and symptomatology of the condition. Vignolo, in 1902, and Franz, in 1905, experimented along similar lines, and the work of the former was the basis of those who followed. San Martin and Satrategui produced fistulæ on goats and had the courage to use their method in the treatment of two patients with senile gangrene, in the hope of opening up new paths to the arterial blood. Both operations, however, were unsuccessful, and amputation became necessary. Stimulated by Jaboulay, Carrel, in 1902, developed his circular arteriorrhaphy, with which he reversed the circulation in various parts of the body and transformed veins into pulsating arteries, and arteries into flaccid veins.

THE TREATMENT OF MALIGNANT TUMORS OF THE THYMUS GLAND BY RADIUM

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DURING the past year a number of patients with primary new growths of the mediastinum have been referred to the Memorial Hospital for treatment with radium. In the case of one of these patients it has been possible to settle the diagnosis exactly by examination of a portion of the tumor removed for microscopical section. Three other patients came to autopsy and an opportunity was thus afforded to study satisfactorily not only the histology of their tumors, but the relations of the primary growth and its extensions through the body. In each of these four cases the diagnosis of a primary malignant new growth of the thymus gland was established by Dr. James Ewing, who made the pathological examination and has reported one of them, and two others not observed by the writer, in a recent article in which he called attention to this group of tumors, thoroughly discussed their histology, and collected and reviewed the literature¹. In two other advanced cases observed by the writer the diagnosis was made from the close resemblance of their clinical course and objective findings to the cases coming to autopsy and proved by microscopical section. Finally, three additional cases which ran a more benign course and came to us at an earlier stage of the disease are herein reported. In these cases, also, the diagnosis rests on the clinical data. The significance of these last three cases, however, is great, for two of them have remained well for long periods since their treatment by radium, one of them for a year and a half, and another for almost a year, the third has only recently been treated.

These results indicate that we have in radium an agent by which we may hope to produce a cure of certain malignant new growths of the thymus gland, and inasmuch as our experience indicates that malignant new growths of the thymus gland are more frequent than has generally been supposed, one should constantly bear in mind the possibility of their presence when studying patients with early thoracic affections.

The probability of obtaining a favorable result in the treatment of these tumors depends not only upon the early diagnosis and application of treatment, but quite as much upon the variety of the tumor with which we have to deal. Ewing states that "pathologically these tumors fall into two main groups

"1 Lymphosarcoma—composed of a diffuse growth of round polyhedral and giant cells

¹ Ewing, James. The Thymus and Its Tumors. Surg., Gynec. and Obstet., 1916, April, p. 461.

"2 Carcinoma—in which the main tumor cell is a pavement, cubical, or, rarely, cylindrical epithelium

"3 Very rarely, spindle-cell or myxosarcoma—believed to arise from the stroma of the gland—may be encountered

"Of these varieties the lymphosarcomas are by far the most frequent. They vary all the way from a process akin in structure to a granuloma with a more limited and slower growth, to a very malignant rapidly-growing tumor composed of a diffuse growth of small round cells in which reticulum cells are largely missing. No attempt has been made in the past to distinguish these tumors from other lymphosarcomas." Ewing emphasizes, however, the fact that on close analysis the round-cell tumors of the thymus are found to differ in structure from the round-cell tumors of lymph-nodes. "The lymphocytes are scanty. The chief cell showing mitosis is often polyhedral with acidophile cytoplasm, vesicular nucleus, and well-developed nucleoli. They often cling to the walls of numerous small capillaries where they assume a cubical or even a cylindrical form. They may produce abortive Hassall's corpuscles. The giant cells are of two main types: (1) Pole-staining reticulum cells with irregular outlines distended with vacuoles and red-cell detritus, and (2) myeloid giant cells with opaque acidophile cytoplasm and many vesicular nuclei. These giant cells differ from the smaller giant cells of lymphatic Hodgkin's disease. The marked fibrosis suggests the desmoplastic property of carcinoma."

"Thymic carcinoma, a much rarer tumor, preserves more perfectly in its cells the epithelial structure. These tumors tend to remain local, though they may produce metastases. As a rule, they exhibit far less tendency to erode surrounding organs than is usual with carcinoma."

The favorable results obtained in the cases of our series which are still well for a year to a year and a half depend, no doubt, upon the fact that these tumors belonged to the less malignant type of lymphosarcoma. The result to date in the case still under treatment, Case IX, though definite, is less marked than was the state of affairs for the same length of time in the other two cases coming for treatment while their tumors were still small. This third early case probably represents a different type of disease histologically. It may belong to the carcinomas. Nevertheless, the results in these three cases, as well as the profound impression made upon the more malignant and rapidly-growing forms illustrated by Cases V and VI, strongly urge the importance of an early diagnosis and familiarity with the clinical course of these tumors.

The first symptom is usually cough without expectoration or hæmoptysis. The cough may be associated at the very first, or very early in its course, with dyspnoea. In the very beginning the majority of these cases are regarded as tuberculous processes in the lung. This was so in the three cases of our series which gave the favorable results under radium treatment. There will be with thymoma an absence of physical signs in

the apices and dullness over the centre of the upper portion of the sternum. If these cases are treated for prolonged periods as tuberculosis, they may lose—depending upon the rapidity of the growth—the opportunity of a very material benefit from treatment by radium. In other cases, the dyspnoea is the pronounced symptom from the start and increases so rapidly that with a very cursory examination it is evident from the beginning that one is dealing with a tumor of the thorax. The very malignant cases of this type may run their course in three or four or even two months' time. The majority of the cases of lymphosarcoma of the thymus metastasize and form extensions into the lung and pleura, and the very malignant cases do so early in their course. Extension through the anterior wall of the chest or through the sternum is characteristic. It has occurred in three of the cases in the present series, has been commented on by other observers, and appears to be of frequent occurrence.

Enlargement of the axillary lymph-nodes may occur before involvement of the cervical nodes, or enlargement of the axillary lymph-nodes may be out of all proportion to the involvement of the cervical nodes. Such rapid extension to the axillary nodes suggests lymphosarcoma of the thymus. As the disease progresses, the dyspnoea becomes extreme, the infiltration into the lungs and pleura increases, hydrothorax develops, the heart becomes displaced, and the large intrathoracic vessels and trachea and bronchi become seriously compressed, with consequent cyanosis and venous congestion of the upper chest, neck, and head. In a special group of cases the blood picture may early resemble that of lymphatic leucæmia. In fact, this diagnosis was made in one case referred to us. Metastatic extension into the abdominal lymph-nodes and organs is frequent, but rarely acquires sufficient headway to cause symptoms before death occurs from pressure within the thorax.

In all cases X-ray examination is the one aid to diagnosis which is of the utmost importance. The location and the appearance of the shadow are characteristic. It is immediately above the pericardium, higher than the usual location of that due to enlargement of the peribronchial glands. The character and the location of the shadow are well shown in the radiographs of the cases herein reported, particularly in Cases VII, VIII, and IX.

The radiograph is thus a valuable means of diagnosis. Many of these cases have hitherto been classed as mediastinal Hodgkin's disease or lymphosarcoma of the mediastinal lymphatics, but most of the true cases of mediastinal Hodgkin's disease have exhibited invasive characters which have aroused the suspicion that they were thymomas. Such errors, however, are not of great practical importance, as both Hodgkin's disease and true lymphosarcoma of the lymphatic glands are best treated by radium.

In conclusion it may be stated that (1) Malignant new growths, particularly lymphosarcomata of the thymus gland are of more frequent occurrence than has hitherto been believed. (2) Radium offers to patients

RADIUM TREATMENT OF THYMUS CANCER

with this disease a real relief, and in certain cases even a prospect of cure (3) Every effort should be made to treat these cases with radium during an early stage, and, in order to do this, the possibility of malignant disease of the thymus should be considered and a radiograph taken in the earliest stages of all intrathoracic affections

CASE I—Mary D, aged forty-eight years, No 23678, applied for treatment November 15, 1916 Her present illness began in February, 1916, with the appearance of a nodule at the middle of the sternum The nodule was hard but not tender It gradually increased in size Shortly afterward a slightly enlarged gland was noticed just above the sternal notch In May, pain began to be felt in the sternum, and in June the sternal tumor had increased considerably in size, involving then the entire region of the upper part of the sternum and its right costal margin The patient then received X-ray treatment and two radium treatments The mass diminished in size, but the axillary lymph-nodes on both sides became much enlarged and later the left cervical lymph-nodes

Examination—The region of the upper portion of the sternum is the seat of a new growth extending from $\frac{1}{2}$ inch above the sternum to a point $6\frac{1}{2}$ inches below From side to side it extends from the left margin of the sternum to a point 4 inches to the right of the sternum The mass is elevated $\frac{1}{2}$ inch above the surface of the surrounding chest wall The most prominent point is at the juncture of the manubrium and gladiolus, just to the left of the middle line, where the tumor is $2\frac{1}{2}$ inches high The overlying skin at the summit of this portion of the mass is necrotic Immediately above the sternal notch is a lump $\frac{3}{4}$ inch in diameter Beneath the middle of the left sternomastoid muscle is a gland the size of a hickory nut In both axillæ are nodular masses the size of oranges

Microscopical examination by Dr James Ewing of a piece removed from the sternal tumor for section in February, 1917, shows a tissue composed of dense hyaline connective-tissue bands and masses of tumor cells in their meshes These cells are as small as or smaller than lymphocytes Their nuclei are very hyperchromatic Traces of cell body stain with eosin Some cells are larger and polyhedral There are no giant cells nor traces of thymus nodules or corpuscles

Diagnosis—Diffuse round-cell thymoma

Treatment—November 17, 1916 540 mc, in 12 3-mm lead tubes, applied over the sternum, at a distance of 2 cm, for three hours

November 18, 1916 864 mc, in 12 3-mm lead tubes, applied, at a distance of 2 cm, for two hours, over the sternum

November 23, 1916 500 mc, in 5 tubes of 1-mm platinum, applied, at a distance of 5 cm, to the left axilla for four hours

November 24, 1916 450 mc applied, in 5 tubes of 1-mm platinum, at a distance of 5 cm, for four hours, to the right axilla

November 25, 1916 The mass in the sternum has practically disappeared

November 26, 1916 384 mc, in 12 tubes of 3 mm of lead, applied, at a distance of 2 cm, to the left side of the neck for ten hours

December 6, 1916 Examination of the chest shows a marked improvement The tumor has practically gone A hard mass is palpable just above the left clavicle, about the size of a hen's egg

Further Treatment—December 16, 1916 600 mc, in 12 tubes of 3 mm of lead, applied, at a distance of 2 cm, to the right side of the neck, for three and one-half hours

December 20, 1916 480 mc, in 12 tubes of 3 mm of lead, applied, at a distance of 2 cm, to the right shoulder, for four hours

December 21, 1916, 720 mc, in 12 tubes of 3 mm of lead, applied to the right axilla, for six hours

January 1, 1917 480 mc, in 12 tubes of 3 mm of lead, applied, for eight hours, to the right side of the neck

This second series of treatments produced only a very temporary improvement The patient died on February 6, 1917

Autopsy by Dr James Ewing showed a primary thymoma

The body is that of a rather poorly-nourished female There are three ulcerated areas on the anterior surface of the chest, each $1\frac{1}{2}$ inches in diameter, and probably due to the action of radium upon tumor tissue

On cutting through the skin we come to tumor tissue directly below the skin, which leads down through the sternum to the mediastinum This extends from the sternoclavicular joint down to about the centre of the sternum The upper half of the sternum is destroyed by tumor tissue There is a large mediastinal tumor, which is about 4 inches broad and 6 inches long, which extends into both lungs and axilla Heart is negative, liver and spleen contain metastases, the kidneys show a diffuse granular nephritis

The tumor is composed of diffusely-growing small round cells, resembling lymphocytes, with very hyperchromatic nuclei

CASE II—J N, male, aged thirty-two years, No 23743, applied for treatment January 21, 1915

History—Previous health good up to two years ago The present illness dates from that time, and first manifested itself by a tenderness in the upper portion of the sternum The tender area became swollen about one year ago, and the axillary lymphatics became enlarged Six months ago he discovered that his temperature became elevated every evening, at times reaching 103° and even 106° , though normal in the morning During the past four months he has had dyspnoea and a cough, and has lost considerable weight One month ago the tumor over the sternum was opened and drained

Examination—In addition to the open wound and swelling 3 inches in diameter over the sternum, the axillary and inguinal lymph-nodes are enlarged and the spleen is palpable below the lower border of the costal cartilages The radiograph of the chest shows a shadow of large size (dimensions not given) in the thymus area of the mediastinum

Following X-ray treatment the patient improved, the mediastinal mass decreased in size, and the patient was discharged

He was readmitted March 14, 1916, again discharged, and readmitted January 2, 1917, having received during the whole period 56 X-ray treatments

On February 9, 1917, no tumor was palpable in the axilla or over the sternum. The shadow in the upper mediastinum had decreased in size. His temperature was normal and he had gained 18 pounds in weight. He left the hospital against advice, and was readmitted March 28, 1917, having been without treatment in the interval. Examination then showed a recurrence of the mediastinal tumor associated with marked infiltration of the chest wall. The patient was very weak and his temperature rose to 103° – 104° in the evenings.

He died May 7, 1917, of hemorrhage.

Microscopical examination by Dr. James Ewing of a piece removed for section from the tumor on the anterior surface of the chest shows the structure of giant-cell thymoma. The morphology resembles that of Hodgkin's granuloma, with excess of peculiar giant cells. The giant cells are large, rounded or polyhedral, with light-staining cytoplasm, nuclei multilobed and hyperchromatic, or multiple and vesicular and with very prominent strongly acidophile nucleoli. They are larger than the cells of Hodgkin's granuloma and somewhat resemble the myeloplakes of bone marrow. They are numerous and appear uniformly over the entire section. The derivation of the giant cells seems traceable to more numerous, smaller rounded or polyhedral epithelioid cells which make up the bulk of the tissue. In some areas the smaller cells are exclusively present while other portions consist chiefly of giant cells. Both frequently show mitosis. The stroma is composed of small arterioles and capillaries with cellular walls, along which the main tumor cells are often arranged as cubical or columnar epithelium. Throughout the section lymphocytes appear in moderate numbers. Necrosis appears in a few areas and also affects isolated giant cells.

CASE III—F. S., aged eight years, male, No. 26223, applied for treatment February 6, 1919. Four months before this time the tonsils became enlarged. A tonsillectomy was performed December, 1918, after which the cervical lymph-nodes, which had already begun to increase in size, rapidly grew larger. An attempt was made to excise them in January, 1919.

Examination—Poorly-nourished, pale child, cervical lymph-nodes much enlarged, some enlargement of the axillary nodes, inguinal glands not enlarged. Marked area of dullness over upper mediastinum. Heart displaced to left, otherwise normal. Abdomen. Spleen enlarged, its inner border within 2 cm. of the middle line and 3 cm. below the level of the umbilicus.

Blood examination shows the picture of lymphatic leucæmia. Red cells, 2,000,000, hæmoglobin, 50 per cent, white cells, 143,000, small lymphocytes, 100 per cent.

Treatment—February 13, 1919. 1436 mc., filtered through 2 mm. of lead, applied at a distance of 10 cm. over the spleen for nine and one-half hours.

The patient died suddenly the next day, presumably from the toxic effect of the products of a sudden excessive destruction of a tissue very sensitive to radium

Autopsy, by Dr James Ewing, showed a general lymphomatosis, affecting especially the thymus gland, the cervical, thoracic and abdominal lymph-nodes—hydrothorax, atelectasis Lymphomatosis of spleen, liver and kidney

Body of a male child, considerably emaciated Two long scars on either side of the neck, large mass of lymph-nodes on left side, small mass on the right side Axillary nodes moderately enlarged and very numerous Recent effusion of blood in the subcutaneous tissue over the sternum The left cervical nodes are fused into a soft affluent hemorrhagic mass, 4 x 5 cm adherent to skin and tissue about trachea and œsophagus The thymus region presents a soft tumor mass 6x8 cm, overlying and displacing the heart to left The heart and pericardium are normal Lymph-nodes at the root of the lung extremely enlarged Left lung slightly compressed, and pleural cavity distended by clear fluid Right lung congested and œdematous, no infiltration

The spleen is moderately enlarged, firm, the section is pale, red, mottled Malpighian bodies very prominent and enlarged Liver slightly enlarged, firm Section opaque, brownish-yellow, markings obliterated and no visible infiltration

Stomach Post-mortem digestion, slight hypertrophy of lymph follicles

Kidneys much enlarged, both replaced almost entirely by a diffuse, opaque, soft tissue resembling leukæmic infiltration

Intestines Peyer's patches moderately enlarged

Colon Slight catarrhal colitis

Bladder, prostate and testes normal

Mesentery Retroperitoneal nodes uniformly but slightly enlarged and soft

Bone marrow Hyperæmic and deep red

There are diffuse extensions of the process into the left parietal pleura, the intercostal muscles, and infiltration of the periosteum of nearly all the ribs, and flat tumor masses extend outward from the spinal column to the mammary line over most of the pleura

Microscopical Examination—All affected organs are infiltrated by a small round cell, without much cytoplasm In general, all cells are small

Diagnosis—Thymic lymphocytoma, lymphæmia

CASE IV—S S, male, married, aged about twenty-five years, No 26153 He applied for treatment January 10, 1919 His illness began four or five months ago with the development of a progressively increasing dyspnœa and pain in the chest and back

Examination shows cyanosis and dilated veins over the chest and neck

The physical examination shows the heart displaced to the left 2½ to 4 cm from the middle line Signs of fluid in the right chest are present below the angle of the scapula behind and the third rib in front The upper part of the chest is dull to flat, below, perfectly flat All over the right side and to a slight extent on the left, the breath sounds are loud, tubular, and whistling

Liver is much enlarged and abdomen slightly distended

RADIUM TREATMENT OF THYMUS CANCER

X-ray examination of the chest shows the entire right side obscured by a dense shadow, which is undoubtedly due to fluid and obscures an underlying tumor mass

Treatment—January 11, 1919 2030 mc, filtered through 2 mm of lead, at a distance of 10 cm, for nine hours

On January 10 the chest was aspirated

The patient failed to improve His dyspnoea increased, and he died on January 20, 1919

Autopsy, by Dr James Ewing, showed a thymic tumor, stenosis of the trachea, right hydrothorax, metastases to the lungs and liver, and retroperitoneal lymph-nodes

The supraclavicular and axillary lymph-nodes are enlarged The pleura over the diaphragm on the right side is the seat of firm, nodular masses, which are somewhat confluent The lung is pressed under the clavicle, its lower border reaching to the fourth rib A mass of tumor tissue firmly binds the lung to the chest wall

The upper part of the mediastinum is occupied by a dense mass firmly adherent to the lung and pericardium The pleura over the right lung is thickened and the seat of multiple nodules, in some regions an inch in thickness The tumor mass in the mediastinum tightly encircles the trachea The left lung is well aerated and almost normal

Pericardium shows multiple nodules over its inner surface, especially prominent around the vessels Small isolated nodules are present in the posterior mediastinum and within the right lung

In the neck are many nodes extending upward along the spinal column almost to the pharynx

Liver The upper surface is studded with large and small tumor nodules Spleen is normal

The stomach posteriorly is firmly attached to a large retroperitoneal mass, to which are also bound the duodenum and both kidneys

Microscopical Diagnosis—The main tumor mass and all the metastases are composed of large round and polyhedral cells with densely staining nuclei Since the main tumor involved the thymus, a diagnosis of thymic tumor is indicated

CASE V—W F, male, twelve years of age, No 29209 February 2, 1919

History—Aside from the usual diseases of childhood, the patient was well until December, 1918 He then, rather suddenly, developed pain in the chest, dyspnoea, and, later, cyanosis These symptoms became gradually worse and a cough developed

Examination—Well-nourished child, with dusky mucous membrane and cyanotic skin, respiration labored The whole of the left chest and upper mediastinum flat, fremitus increased, respiratory murmur absent, right chest percussion normal, breathing vesicular Loud-blowing systolic murmur heard over the base, loudest over the second right space and transmitted to right Over the centre of the sternum is a bluish, soft, discoid swelling 3 cm in diameter The axillary lymph-nodes on both sides are enlarged, cervical nodes are not enlarged The abdomen is normal X-ray examination of chest shows the left side almost entirely filled by a dense tumor

mass, except at the extreme apex and along the lateral border of the ribs. A small amount of fluid is present in the lower left pleural cavity. The peribronchial glands around the left hilus are enlarged.

Treatment—1500 mc hours, filtered through 2 mm of lead, were applied to the sternum at a distance of 10 cm. Improvement was apparent the next day. The dyspnoea cleared up, the venous congestion of the face, neck, and upper part of the chest disappeared, the tumor on the front of the chest completely retrogressed.

February 11, 1919. 103 mc of active deposit of radium were administered intravenously. The injection did not produce further improvement, in fact, there gradually developed a recurrence of the dyspnoea. Between February 18 and March 4, 10 X-ray treatments were administered. These were distributed over the chest, back, axillæ, and supraclavicular regions.

February 15, 1919. 19 ounces of fluid were withdrawn from the left chest.

March 5, 1919. The father of the child decided to take the boy home and continue the treatment with X-rays at home. When he left he was improved, but not markedly so, and died at his home on March 26, 1919.

There can be no question but that this case is also a thymoma. The location of the shadow in the anterior mediastinum, the late involvement of the lymphatic glands—particularly the fact that the axillary lymphatics were first and most extensively involved—and the appearance of the tumor through the anterior chest wall, are all characteristic features.

CASE VI—M. J., male, aged twenty-nine years, No. 24398, appeared for treatment December 7, 1917.

History—Seven or eight months ago the patient noticed some swelling in the neck, which he attributed to an enlargement of the thyroid gland. At the same time dyspnoea developed which so increased up to five months ago that his condition became desperate. He was cyanotic and could not lie down. He was operated upon by his local physician, who removed what he considered a goitre. The mass was soft and found to contain pus—probably degenerated tumor tissue. Sections of tissue removed showed the structure of lymphosarcoma. A temporary improvement followed this operation, but two months later the former dyspnoea returned, but was relieved by four X-ray treatments over the chest. During the past three weeks there has been a gradual return of the dyspnoea.

Radiographic examination shows a wide mediastinal shadow, 17 cm in diameter at the level of the manubrium, and 15 cm wide at the level of the angles of the scapula. The heart and large vessels are obscured. The cervical lymphatic glands in the supraclavicular spaces of both sides are enlarged.

Treatment—December 8, 1917. 1000 mc, filtered through 2 mm of lead, applied over the sternum for eighteen hours, at a distance of 10 cm.

Following this treatment the improvement was very great and

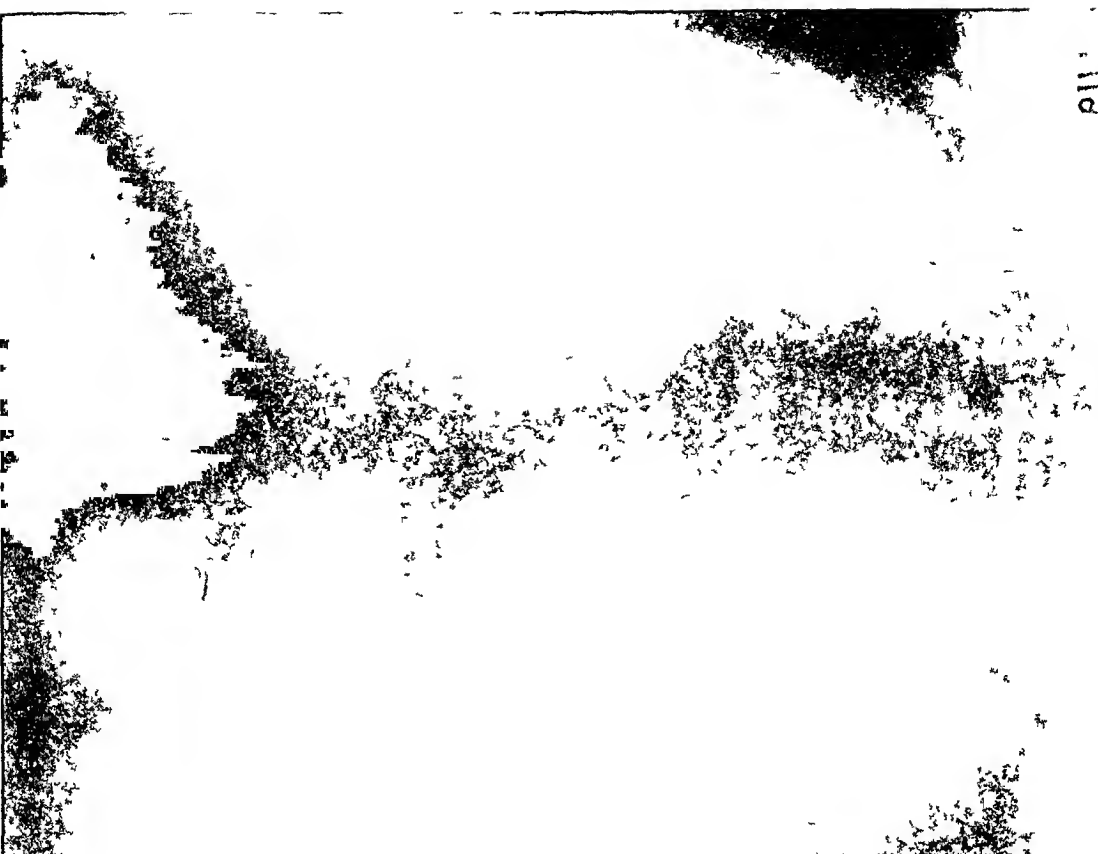


FIG. 1.—Rontgenogram of Case VII taken February 11 1918 at the time the patient applied for treatment. The location and character of the tumor are typical of a growth of the thymus gland.

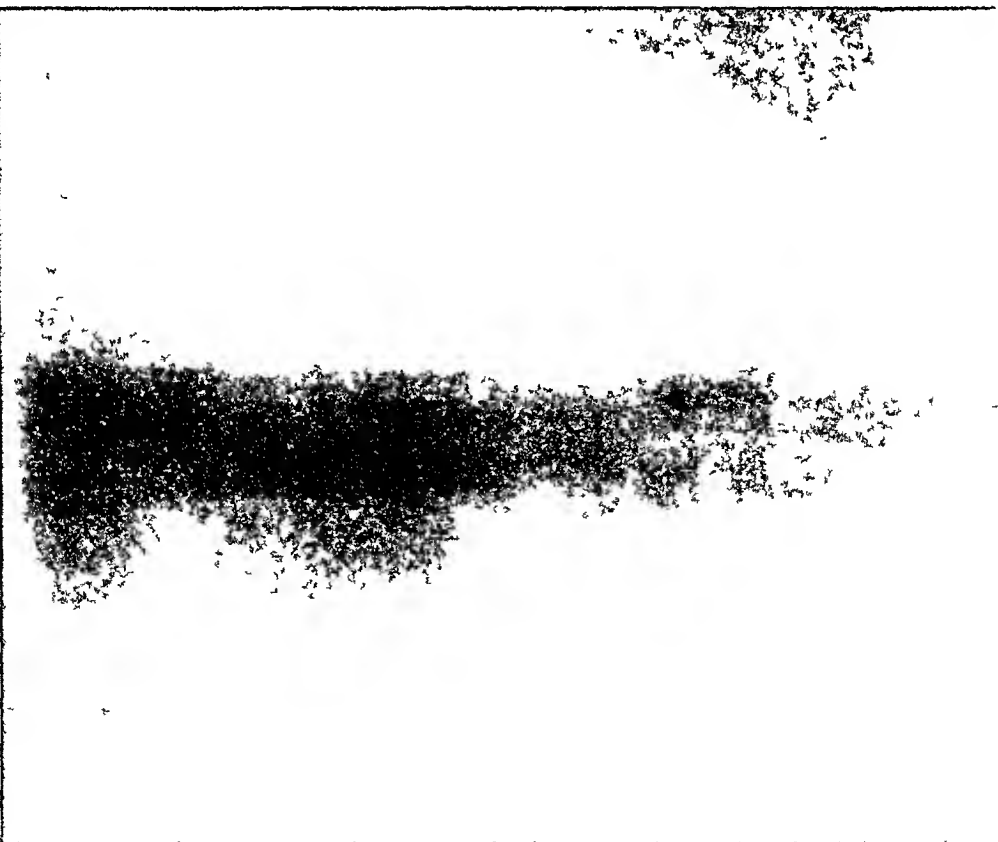


FIG. 2.—Rontgenogram of Case VII made October 22 1918 showing disappearance of shadow of tumor.



FIG 3 —Rontgenogram of Case VIII, June 12, 1918 Typical of thymus tumor

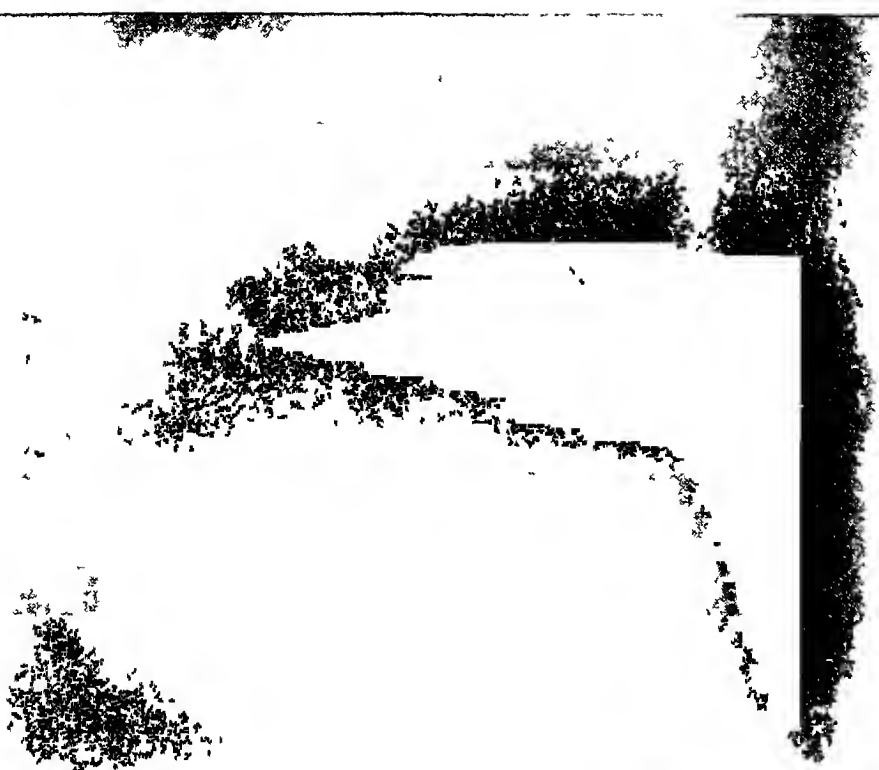


FIG 4 —Rontgenogram of Case VIII made May 8 1919 showing improvement nearly one year after treatment



FIG 5 —Röntgenogram of Case IX on April 25, 1919 showing early thymus tumor

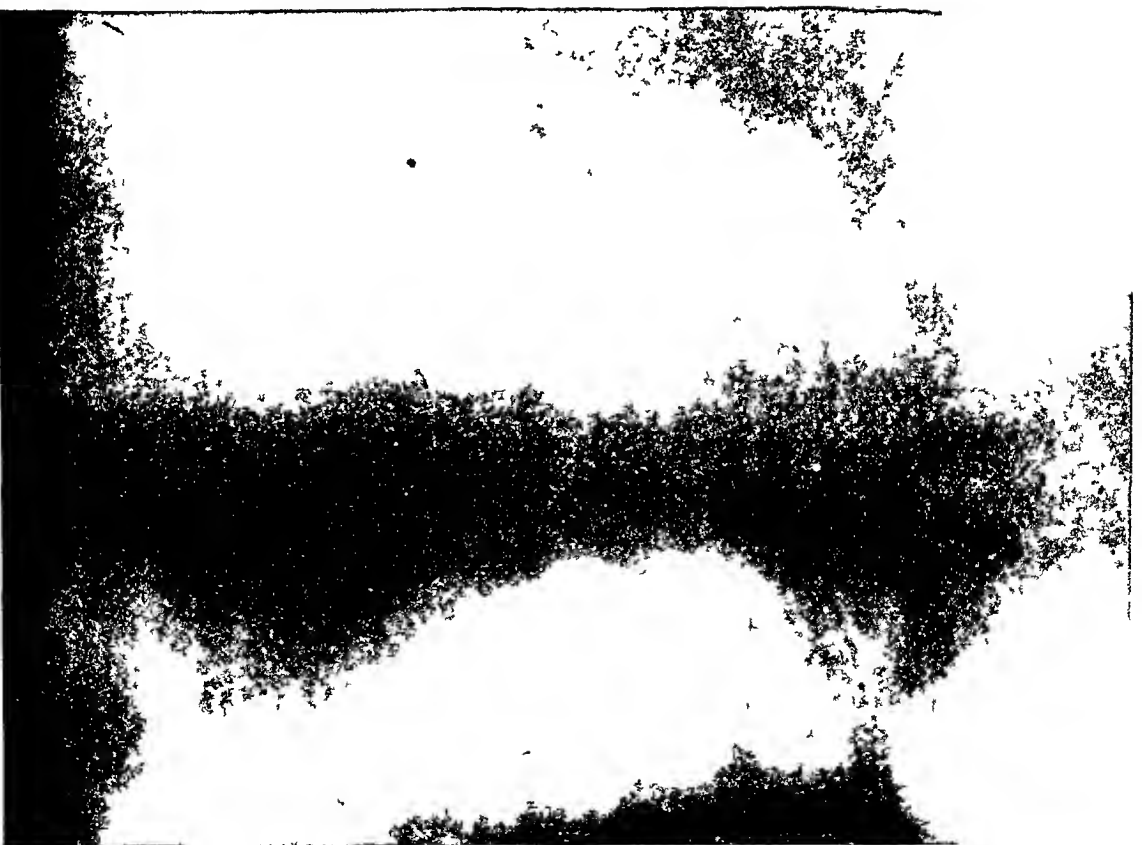


FIG 6 —Röntgenogram of Case IX May 23, 1919, one month after treatment showing very slight diminution of size and density of shadow

RADIUM TREATMENT OF THYMUS CANCER

treatment was continued January 20, 1918, when 1700 mc, filtered through 2 mm of lead, were applied at a distance of 10 cm for four and three-quarter hours. Further improvement followed and was described in a letter as follows by the roentgenologist who followed this case in Baltimore from whence the patient came for treatment: "The first roentgenogram made December 4, 1917, at St Agnes Hospital, shows a single tumor shadow strongly suggestive of a lymphosarcoma occupying the centre of the chest cavity and extending well to both right and left sides. The blood-vessels and practically the entire heart are obscured by this shadow. A roentgenogram made December 17, 1917, after the first radium treatment, is clear cut, the heart is well defined, but in the region of the blood-vessels, especially at the arch, it is much wider than normal."

Rontgenograms made on January 23 and February 5, after the second radium treatment, reveal practically a normal chest picture with the exception of a very slight widening in the region of the ascending arch of the aorta.

Later we received a note stating that the patient died on March 13, 1919. It appears that death occurred suddenly and in some attack associated with high temperature, as if of some acute infection.

In this patient again the final proof that we are dealing with a primary malignant tumor of the thymus gland is wanting, the evidence being only clinical and depending upon the site of the growth.

CASE VII—D M, female, aged fourteen years, No 25173, applied for admission February 1, 1918. She had suffered from attacks of "auto-intoxication" between the ages of six and ten. These attacks were severe between eight and ten years of age. Between ten and thirteen years of age her health was excellent. In the summer of 1917, while in the Adirondacks, she began to feel tired and developed an evening rise of temperature. She became so ill that she was kept in bed for two or three weeks and lost 15 pounds. At the same time she developed a cough and irregularity of heart action. After leaving bed, she attempted to go to school, and though somewhat better, she never regained strength or felt well during the whole of the next winter. About the middle of January, 1918, she noticed that there was some enlargement of the supraclavicular nodes on both sides.

She began treatment on February 2, 1918. At that time the deep cervical and supraclavicular lymphatic glands were slightly enlarged on both sides of the neck. The roentgen examination discloses a mediastinal mass at the level of the thymus (Fig 1).

Treatment—February 2, 1918. 5076 mc hours, filtered through 2 mm of lead, at a distance of 4 cm, applied over the upper portion of the sternum.

Between February 4 and June 6, 1918, she received 15 X-ray treatments distributed over both sides of the neck, both supraclavicular regions, and both axillæ.

Subsequent course—March 7, 1918, X-ray examination showed that the mediastinal mass had diminished 2 cm in diameter.

March 30, 1918 Further reduction in the mediastinal mass Her health had improved much and the cough was less

June 12, 1918 General health good, no cough, no glands palpable on the right side of the neck, only pea-sized nodules on the left side, and continued reduction of the mediastinal mass, 727 mc, filtered through 2 mm of lead, applied at a distance of 4 cm, over the upper part of the sternum for seven hours

September 9, 1918 1736 mc, filtered through 2 mm of lead, applied over the upper part of the sternum at a distance of 4 cm for two and nine-tenths hours

Following this date the conditions in the mediastinum remained unchanged

May 5, 1919 The general health of the girl had remained excellent, and X-ray examinations gave no evidence of a recurrence of the mediastinal growth (Fig 2)

CASE VIII—G K, male, aged twenty years, No 25565, applied for treatment June 15, 1918

History—Aside from pneumonia four years ago his previous health had been good His illness began with the development of a cold accompanied with cough in October, 1917 During the next month or two this alternately improved and became worse In February, 1918, he developed pneumonia with which he was ill in bed for four weeks His physician believed that he had tuberculosis and a little later referred him to Doctor Trudeau's sanitarium, where he remained eight weeks until June 1 When he went there he had a cough with mucous expectoration, but no blood, severe pain in the left side of the chest, and some pain in the right chest At the time he left the cough had ceased and the pain had disappeared He had also gained in weight from 114 pounds to 130 at the time of leaving On his return to New York he was referred to us for radium treatment, solely because the X-ray examination of his chest showed the presence of a mediastinal mass

The roentgenological examination at the Memorial Hospital on June 22, 1918, showed a large well-defined mediastinal mass (Fig 3) Its upper limit extended to the level of the clavicles The lower border was on a level with the second rib The shadow of the tumor measured 12 cm in diameter

On the right side the mass extends outward beyond the right border of the heart, and from the right hilus an infiltrating process extends into the right middle lobe of the lung, the upper border of which is sharply defined There is one discrete large gland at the left hilus

The patient has the general appearance of a fairly well-developed young man who is not very well nourished and who looks ill The heart is normal and the abdomen is normal

Treatment—June 16, 1918 919 mc, filtered through 2 mm of lead, applied over the upper part of the sternum at a distance of 10 cm for twenty-two hours

RADIUM TREATMENT OF THYMUS CANCER

Between June 18 and 22 he received five X-ray treatments Examination June 22, 1918, shows definite improvement

July 1, 1918 Marked diminution in the size of the mediastinal mass

May 15, 1919 The general health of the boy had remained good and an X-ray examination gave no evidence of a recurrence of the growth (Fig 4)

CASE IX—A W, male, No 26424, applied for treatment April 27, 1919 Previous health good During the past summer developed a dry cough and some slight dyspnoea on exertion

Physical examination disclosed a normal chest except for dullness over the upper mediastinum

The general appearance of the patient is that of a well-developed and healthy man Radiographic examination of the chest shows a flattened spherical mass $9\frac{1}{2}$ cm in diameter lying immediately behind the upper end of the sternum with its centre opposite the sternal notch Its location is typical of thymus tumor (Fig 5)

Treatment—April 27, 1919 1058 mc, filtered through 2 cm of lead, and applied at a distance of 10 cm for eighteen and one-half hours over the upper anterior mediastinum

May 24, 1919 Second radiograph shows a very slight decrease in the diameter and density of the tumor (Fig 6) The general condition of the patient is improved, while the location of the roentgenographic shadow of this tumor is typical of tumor of the thymus gland The failure of the growth to respond more to the radium treatment indicates that tumor is different from the type of lymphosarcoma present in the other cases

MALIGNANT DISEASE OF THE LUNGS, ITS EARLY RECOGNITION AND PROGRESSIVE DEVELOPMENT, AS STUDIED BY THE RONTGEN RAYS, WITH REMARKS ON TREATMENT*

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PRECEDING the study of the chest by means of the rontgen rays, an antemortem diagnosis of malignant disease of the lungs, according to Warfield, was not made in a large percentage of cases because of the general good condition of the patients and the indefinite symptoms which this disease produces. Even with the study of the chest by means of the rontgen rays, I am sure that the disease is not generally recognized in its earliest stages. In its earliest stages I believe that it cannot be definitely diagnosed by any means. In its latest stages it should not be mistaken by any rontgenologist. By reviewing the rontgenograms of a large number of patients, some of which have been followed over a period of several years, during which we have studied the progressive changes in the lesions, and by reversing the study, we have been able to trace the gross lesions back to their very incipency. As a result, I am hoping that we shall be able to recognize this disease much earlier than it has ever been recognized heretofore. There is, of course, a microscopical stage in its development at which time we can never hope to recognize the disease.

Its early recognition will serve as a guide in the treatment. In some instances it will prevent a mutilating operation, and I am hoping in the future that its early recognition may lead to the early institution of some form of constitutional treatment which is, as yet, undiscovered. I am sure that at present many patients are operated upon with the hope of complete recovery at a time when there is already distinct metastasis in the lungs and mediastinum. On this account I believe that we should urge a rontgen examination preceding all operations for carcinoma of the breast. When the lesions within the chest are doubtful, I believe that they should not stand in the way of an operation.

Malignant disease of the lungs may be divided into *primary* and *secondary* (or metastatic).

Primary malignant disease of the lung is rare. It is of two types: the nodular and the infiltrating. The nodular type consists of nodules developing near the roots of the lung, but also in the parenchyma, and consists of varying sized masses, rather sharply defined and irregularly outlined. The infiltrating type, which is the more common, begins at the root of the lung and gradually infiltrates the entire lung. This fills the entire chest, and may come on so gradually, and produce such indefinite

* Read before the Philadelphia Academy of Surgery, January 5, 1920.

symptoms, that the disease is not suspected until the entire lung has become filled, and until one side of the chest is entirely solid, associated with marked displacement of the heart and mediastinal tissues to the opposite side, and associated with the formation of pleural effusions early.

The symptoms associated with primary malignant disease of the lungs consist usually of dyspnoea, pain, with or without pleuritic friction, and dullness varying with the degree of the involvement of the lung. As a result of the extensive dullness, the first thought is a pleural effusion, but in aspirating the chest only a relatively small amount of fluid is obtained, and this is generally a bloody serum. When bloody serum is obtained in a relatively small amount, malignant disease should always be suspected, and a roentgen examination should be made if it has not been made previously. By means of the roentgen rays, one recognizes an opacity in the early stages consisting of a mass of infiltrating dense tissues about the root of the lung spreading towards the periphery. If the malignant disease is sarcoma, it is especially apt to extend outward along the septum between the upper and middle lobe, or between the upper and lower lobe on the left side, or about the middle lobe on the right side, and this may be a fairly early sign. If the primary malignant disease is carcinoma, it consists of an infiltrating mass about the root of the lung extending outward along the bronchial tree, I believe most frequently in an upward direction, which serves somewhat to distinguish it from the inflammatory infiltrations about the root of the lung which tend to spread downward. In the late stages the whole of one side of the chest is a uniform dense mass with displacement of the heart and mediastinal tissues to the opposite side, with generally clear lung on the opposite side. The lung area on the opposite side may be reduced to one-third or less. In less advanced stages the apex of the lung may remain clear and the lower portion of the base of the lung may remain clear, unless there is associated pleuritic effusion. Sometimes by varying the position of the patient this lower portion of the base of the lung can be demonstrated to be clear by displacement of the fluid upwards.

Secondary or metastatic malignant disease of the lung is very common, and I believe much more common than has been recognized up to the present time. In a quotation made by Warfield in the report of cases studied in Middlesex Hospital, he states that metastases were found in the lungs of 178 out of 516 autopsies performed on persons who had died from cancer of the breast, and he states that at least one-third of all patients dying from cancer of the breast have metastasis in the lungs. It would seem to me, from my studies, that the proportion would be even higher than this. Gross found in 432 autopsies, collected from various sources, metastases in the lungs in 49.9 per cent.

Metastatic sarcoma, in my experience, has mostly followed sarcoma (?) of the testicles, though it may, of course, be secondary to sarcoma anywhere in the body. The lesions are nodular and occupy more particularly

the parenchyma of the lungs They are generally sharply defined and vary in size from a small pea to an English walnut, or rarely as large as an orange They are probably carried to the lungs in the blood stream and are distributed as emboli in the terminal blood-vessels in the parenchyma In none of these cases studied by me did the patients have any lung symptoms, and the disease in the lungs had not been suspected by the physicians who referred the patients—generally for treatment of some local recurrence or some other metastasis This condition of metastatic sarcoma of the lungs occurs so frequently, in my experience, that I never start treatment of a sarcoma without examining the chest, and when metastatic sarcoma of this kind is found within the chest, the rontgen treatment has been of no avail

Hypernephroma metastasizes early to the lungs, and I believe the chest should be examined in every case in which hypernephroma is suspected, or whenever hypernephroma has been diagnosed In one case sent to me for post-operative treatment three weeks after the operation for hypernephroma, in which the patient's general condition was good and there was no thought on the part of others as to recurrence or metastasis, I made an examination of the chest and found undoubted evidence of infiltration of the lungs This consisted, not of nodules, but of a general infiltration of small miliary bodies extending outwards from the roots of the lungs which somewhat resembled an infiltrating tuberculosis, but the lesions were more sharply defined and did not follow the usual distribution of tuberculosis The appearances were sufficient to make a diagnosis when associated with the history, and the subsequent development of the case proved that my diagnosis was correct I am not sure that this diagnosis could have been made from the plates without the previous history

Metastatic carcinoma of the lungs, in my experience, has most frequently followed carcinoma of the breast However, it must be admitted that I have had very much more opportunity of studying this group of cases than those belonging to malignant disease in any other part of the body I have studied the chests in 225 cases of malignant disease of the breast At present I make a chest examination of every patient referred to me for rontgentherapy for carcinoma of the breast, whether for the primary disease, ante-operative, or post-operative treatment There have been long intervals in the past when I did not follow this procedure My experience now convinces me that this should always be done Metastatic carcinoma of the lung is of four types

1 The *nodular type*, which we all have recognized for many years, and which is characteristic as early as the nodules can be demonstrated These nodules are generally distributed in the parenchyma of the lungs, though they may be located about the roots as well as in the parenchyma These nodular lesions vary in size from that of a pin-head to an English walnut They are generally not very dense and are not sharply out-

lined, but present a fuzzy appearance suggesting cotton balls. They are very much less dense and less sharply defined than metastatic sarcoma, though their distribution is very similar. This is the type that has been particularly studied and described by Moore and Carman. Apparently no other type was recognized by them at the time of the complete and able presentation of this subject before the American Rontgen Ray Society in September, 1915. They describe the lesions as varying in density from a faint shading to a degree approximately that of the heart, depending on the stage of the disease. At the time of the presentation of this paper it was undoubtedly the most complete rontgenological study of this disease made up to that time, and in general represents our knowledge of the subject up to that date. They had made a study of 71 cases. The character of the distribution of these lesions would lead one to suspect, as Moore and Garman also suggest, that these metastases are embolic and travel through the blood rather than through the lymph streams.

2 *The infiltrating type, beginning at the hilus or mediastinum.* This, I believe, is the most common type and, as has been so well said by Holmes and Ruggles, is "unrecognizable in the early stages and unmistakable in the later ones." This begins as a general thickening or infiltration about the hilus which, in its earliest stages, resembles the inflammatory thickenings that we so commonly find in this region, but which I believe differs slightly in that it presents more localized density without outline at the very roots of the lungs. It then shades so gradually as it extends outwards that it is lost in outline. I think I notice, too, a greater tendency towards an extension upward about the upper bronchial tree and toward the upper lobe than is usually found in the inflammatory lesions, for, as we know, in the chronic inflammatory lesions giving rise to thickening about the hilus of the lungs, there is a tendency towards increased thickening about the lower bronchial trees as compared with the upper. This evidence, however, in this early stage is only suggestive, and is not characteristic. As the disease progresses this area of density increases, extending toward the periphery, but extending particularly toward the upper lobe. Associated with this there is a general increase in the width and density of the mediastinal tissues. In some cases this mediastinal thickening is greatest in the upper portion just below the inner extremities of the clavicles, and at times distinct masses can be recognized in this upper mediastinum. It would seem, from the location and general distribution and development of the disease in these cases, that it is a direct extension through the lymphatic system, just as it commonly extends through the palpable glandular system into the axilla, then into the supraclavicular region, and then into the mediastinum. Handley concludes that the vast majority of metastases are due to lymphatic permeation. It has seemed to me that, in some cases, I have been able to transform these lesions into dense fibrous tissue and, in a few cases, the patients are still living after several years. One patient is living nine

years after removal of both breasts for malignant disease, and eight years after definite mediastinal involvement. She has been treated by roentgentherapy and looks well.

3 The *miliary infiltration* (very similar to miliary tuberculosis), and consists of a fine mottling throughout the lung fields, but, as recognized also by Holmes and Ruggles, these small areas of increased density are a little larger, more dense, and more sharply outlined than those of tuberculosis. This type is more difficult to diagnose, I believe, than any of the others, and it is likely that the diagnosis could not be made excepting in association with the history and careful study of the clinical symptoms. The absence of fever and the absence of other symptoms of miliary tuberculosis will easily eliminate tuberculosis in the differential diagnosis. An infiltrating syphilitic lesion of the lungs may resemble it, but can be differentiated by means of a negative Wassermann test. Infiltration of the lungs associated with leucæmia also resembles this form of metastatic carcinoma, but a careful differential blood examination will eliminate the diagnosis of leucæmia.

4 This type consists in a *progressive thickening of the pleura* associated with pleural effusion. This type is probably a direct extension of the disease from the breast into the pleura. Deaver and McFarland say that in "advanced cases the intercostal muscles often become diseased, and in some instances the pleura is involved as a result of the extension of the cancer cells through one or other of the intercostal spaces." Handley found secondary nodules in the pleura in 38 per cent of 422 cases.

It would seem, from the above types, that all the various theories as to the nature of the extension of metastatic carcinoma are clearly illustrated and that all the theories are correct in certain cases.

In a series of cases studied previous to July 1, 1919, consisting of 242 cases of carcinoma, we found positive evidence of pulmonary carcinoma in 216, negative, 29, doubtful, 7. This high percentage of positive findings is partially influenced by the fact that, in many instances, the examinations were made because disease was actually suspected in the chest, but it also indicates the advanced stages of the disease in which the majority of patients are referred for roentgentherapy.

Of the 216 cases of malignant disease of the lungs there were: Primary carcinoma, 2, metastatic carcinoma, 196, primary sarcoma, 7, metastatic sarcoma, 11.

Of the cases of metastatic carcinoma of the lungs the great majority were secondary to carcinoma of the breast. I am not specifying the number because it would give a wrong impression, since all patients suffering from carcinoma have not been examined. Of the cases of metastatic carcinoma of the lungs there were: Mediastinal and hilus involvement, 150, nodular, 34, miliary, 10, pleural, 12.

It is evident, therefore, that the mediastinal and hilus cases are almost five times as frequent as the nodular.

MALIGNANT DISEASE OF THE LUNGS

The statement has been made that fat patients are more liable to early and rapid metastasis than thin patients. I, therefore, studied the various groups as above arranged, with the idea of determining whether any of these groups were especially liable because of the amount of adipose tissue. Also to confirm or deny, if possible, the above statement as to the relation of fat and metastasis.

Of the mediastinal and hilus variety there were fat patients, 53, medium, 65, thin, 32. Nodular variety, fat, 5, medium, 17, thin, 12. Miliary, fat, 6, medium, 4, thin, none. Pleural, fat, 4, medium, 5, thin, 3.

It would seem, therefore, that the thin patients are slightly more liable to the nodular variety of metastatic carcinoma, and second that the fat and medium patients are very much more liable to metastasis than the thin.

In a series of 42 cases studied since July 1, 1919, in each series all patients who were sent for post-operative treatment following carcinoma of the breast were examined, and we found positive metastatic carcinoma, 17, doubtful carcinoma, 16, negative, 9.

It would seem, from these studies, that approximately 50 per cent of the cases that come for post-operative treatment have metastatic carcinoma within the chest at that time. The effect of roentgentherapy on these pulmonary lesions is difficult to determine. One does not generally have the opportunity of studying these patients over a long period of time unless they are under some form of treatment. Therefore, we do not have the opportunity of comparing the progressive changes in a group of untreated cases with the changes that I can recognize in the patients which have been treated. In some of these patients treated some of the lesions seemed to have disappeared temporarily. In others, the lesions become more dense and more fibrous, resembling somewhat a fibroid phthisis. In a few instances the patients are still living several years after beginning treatment, and are apparently in good health. In most cases, however, while there is temporary improvement extending over a period of months or a year, the disease takes on a more rapid form of development with evidence of general carcinomatosis followed by death. The symptoms and roentgen findings which develop as a result of progression of the disease most frequently involve the spinal bones, but also frequently involve the upper extremities of the humeri and the upper extremities of the femurs. The liver, in the cases which I have had under treatment, has not become involved, as indicated by symptoms of enlargement, as frequently as one would suspect from the text-book statements.

Rontgentherapy in these cases does accomplish some good, and, in a number of cases, definite disappearance of lesions has been proven. One patient was referred to me by the late Dr Wm L Rodman, who had one breast amputated and found to be sarcoma, and the other breast amputated a year later and found to be carcinoma, and then, within six months she was referred to me with a very definite mediastinal tumor, and this

was nine years ago She is to-day in reasonably good health, is very stout, and X-ray examination shows partial calcification of this tumor In some other patients I have found disappearance of the metastatic nodules in the lungs, and in others disappearance of the mediastinal involvement In five patients I have been able to get a healing process in metastatic carcinoma of the spine I have been able to get reformation of portions of ribs that had been destroyed by metastatic carcinoma, or at least in which the lime salts had all been removed, so that the outline of the rib could not be seen at the area of disease These have reformed Such results are only obtained occasionally, however I believe that all cases can have their lives prolonged and perhaps made more comfortable

In general, I believe that when the lungs are involved it must be looked upon as a part of a general carcinomatosis, and with few, if any, exceptions one cannot expect a complete and permanent recovery

CONCLUSIONS

1 Primary malignant diseases of the lung is rare, but presents rather characteristic appearances rontgenographically

2 Metastatic malignant disease of the lung is common, and should always be looked for in connection with advanced malignant disease

3 A rontgen examination of the chest should be made in every case of carcinoma of the breast referred for operation or rontgentherapy

4 Metastatic carcinoma of the lungs may be one of four types Nodular, mediastinal with infiltration about the roots, general, miliary infiltration, or pleuritic

5 Greater attention to details in these studies will lead to earlier recognition of the disease

6 Rontgentherapy can be expected to prolong life and give some improvement in symptoms, and perhaps occasionally the life may be prolonged sufficiently to consider it a cure

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CIRCUMSCRIBED PAN-MURAL ULCERATIVE CYSTITIS*

ELUSIVE ULCER (HUNNER)

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IN 1914 Hunner presented his first report of eight cases of a rare type of bladder ulcer in women (Hunner, G. L. *Tr South Surg and Gynec Assoc*, 1914, 27, *Boston Med and Surg Jour*, 1915, 172, 660). He has subsequently reported seventeen additional cases under the title of "Elusive Ulcer of the Bladder" (Hunner, G. L. 1918, *Amer Jour of Obstet and Diseases of Women and Children*, lxxviii, No. 3). During the past three years, ten such cases have been treated on Dr. John G. Clark's service at the University Hospital and this paper is based upon our findings in these patients.

While this type of lesion is undoubtedly rare, we are confident that it is often overlooked not only because of failure to make a careful inspection of every portion of the bladder, but also to lack of proper interpretation of the findings which in the earlier cases may show very little variation from the normal so far as gross changes are concerned. In looking back over our own experience in cystoscopic work, we recall cases that were doubtless of this type, in which the condition was overlooked completely, or, recognizing it, we failed to direct appropriate treatment for its cure.

This error was forcibly impressed upon us by a case, long under our care, who finally consulted and was operated upon by Doctor Hunner; at operation he demonstrated, without question, the extent of disease and the complete cure in this case left no doubt as to the wisdom of his teaching regarding the value of excision.

Hunner has described the condition under the name of "Elusive Ulcer," choosing the term to designate the difficulty often experienced in locating the ulcer. Such a nomenclature seems unsatisfactory in that it gives no conception of the pathology and, in fact, may be misleading in that it magnifies the importance of the ulcer which in reality is a small part and but an end result of an inflammation involving a considerable portion of the entire bladder wall. The lesion brings to mind a type of disease which Nitze calls Cystitis Parenchymatosa (Knorr *Die Cystoskopie und Urethroskopie beim Weibe*, p. 211), in which not only the mucosa but the submucosa and muscularis participate, and until recently we have spoken of the lesion we are about to describe as a circumscribed parenchymatous ulcerative cystitis. Dr. Allen J. Smith has suggested

* From the Department of Gynecology, University of Pennsylvania. Read before the Philadelphia Academy of Surgery, January 5, 1920.

that the word "pan-mural" be substituted for "parenchymatous," pointing out the fact that the former is more accurate in its application to the pathology of the bladder as well as more descriptive of the extent of the inflammation, and we have followed his suggestion

*Pathology*¹—Grossly, the lesion is characterized by more or less thickening of the entire bladder wall with œdema and minute, superficial ulceration of the mucosa. The disease is practically always limited to the vertex of the bladder, although rarely it may extend downward and laterally on one or both sides to within a few centimetres of the trigone. The amount of bladder wall involved varies considerably, of our operative cases, the tissue removed ranged from 2 by 3 centimetres to 7 by 7 centimetres. The disease is never "patchy" in distribution, but is limited to one section of the bladder. The bladder wall is distinctly firmer than normal and in two of our cases the induration could be detected on bimanual examination. The inflammation may extend beyond the bladder confines, not infrequently involving the paravesical tissues and adjacent peritoneum. Such a paracystitis is most commonly found in association with and in the immediate vicinity of a comparatively large ulcer.

The mucosa is thickened and œdematous and with proper illumination the diseased area stands out in sharp contrast with the normal bladder. The ulcers may be single or multiple, in our series the latter has occurred more commonly, but in no case have we found more than three. The areas of ulceration are always minute and very superficial, because of this one may at first glance have difficulty in locating them. The ulcer usually presents a clean, bright red surface with sharply cut edges. The lightest touch with a cotton-covered probe will be followed immediately by bleeding.

Microscopically, the picture is that of an inflammation involving the entire bladder wall and paravesical tissues. The bladder wall is thickened, due in small part to fibrous tissue, but largely to loosening of the intermuscular and paravesical connective tissue incident to œdema. Within the areas of ulceration, the inner surface of the mucosa fails to show the presence of the ordinary epithelium, the basement membrane is, as a rule, well marked and is often somewhat thickened. Immediately beneath the basement membrane in the non-ulcerated portions are areas of dense round-cell infiltration, consisting mainly of lymphocytes and plasma cells. Where there is loss of the surface epithelium, the fibrous tissue is very loose and is filled with polymorphonuclear leucocytes.

The deeper part of the submucosa may be fairly free from an inflammatory exudate and shows little change save loosening from œdema, but its blood-vessels often stand out prominently, due to the number of polymorphonuclear leucocytes which are seen not only within the lumen,

¹I am greatly indebted to Dr Allen J Smith and Dr Charles C Norris for their interest and assistance in the study of these sections



FIG. 1.—Cystoscopic picture showing diseased area above and normal mucosa with ureteral orifices below. Intense congestion about three small superficial ulcers which are situated in lower portions of the oedematous zone. Section excised measured 7 x 7 x 4 cm. The disease was located in the vertex of the bladder but is here shown near the base in order to demonstrate the essential features in one drawing.

but infiltrating the vessel walls and perivascular tissues. Here mononuclear cells are fairly rare, only an occasional large mononuclear being seen.

The same vascular and perivascular polynuclear invasion affects the blood-vessels in the muscular and outer coat, being often very marked in the latter, so that a leucocytic thrombus is in many instances apparent, and the leucocytic involvement of the coats is such that one would speak of an acute exudative arteritis and phlebitis. The appearance is given that the lymph channels are similarly affected. Foci of round-cell infiltration likewise occur in the muscle fascicles, but no degenerative changes have been observed.

Cystoscopic Picture—The picture presented by the cystoscope (Fig. 1) is fairly typical in most cases, and having seen one or more, the observer is immediately aware of the fact that he is in all probability dealing with an ulcer-bearing area. The most striking feature is oedema of the mucosa, localized in the vertex of the bladder. The oedematous area is somewhat hazy, there is an absence of sharp definition of the vessels, or the vessels may appear unduly short, seeming to suddenly appear in the field, and after a short distance, completely disappear from view. Or they may be seen in small clusters, giving a "flea-bite" appearance in one or more areas.

The mucosa has lost its normal golden-white, glistening surface, and has assumed a more or less diffuse, dull pink color. Occasionally one sees elongated, elevated areas of mucosa which give the appearance of scar tissue, and in one of our cases two small ulcers were mounted at the summit of such an area. With a well distended bladder and good illumination, one can make out very clearly the sharp line of demarcation between the normal and oedematous mucosa.

The ulcers give the appearance of minute areas of healthy granulation tissue, the base being a deep red color and rarely covered with fibrin. Through the cystoscope the ulcers stand out even more plainly than with the naked eye, they present sharply cut edges and are always superficial, appearing as if minute areas of mucosa had been removed with a sharp curette. They are always small, varying in our cases from 1 by 2 mm. to 4 by 5 mm. Surrounding the larger ulcers is an area of intense congestion and oedema which the smaller ulcers often lack. As has been our experience in two cases, the ulcers may show active bleeding. Touching the ulcer with a catheter or probe at once produces bleeding, and the patient will complain of sharp pain. The bladder base, including the trigone and ureteral orifices, is always normal in appearance, not uncommonly, as the result of frequent urination, papillary hypertrophy of the internal sphincter is present.

Symptoms—An analysis of the symptoms presented by our patients gives one common to all—bladder pain with intense urgency and frequency of urination. In the most severe cases the bladder must be emptied every few minutes, with pain during, but more especially after,

urination. Often the dysuria is exaggerated at night, but the reverse may be true. There is an associated intense urgency, so that the patient finds it next to impossible to hold the urine. Not infrequently the pain is located in the lower abdomen, usually just above the symphysis on one or both sides of the median line. This is doubtless due to an extension of the inflammation to the peritoneum and the pain may closely simulate that of a chronic pelvic peritonitis or appendicitis. The pain may be localized to the bladder and lower abdomen or may be referred, in one of our cases intense rectal discomfort was complained of, in another a sensation of "spasm" in the perineal region, and Hunner calls attention to the frequency of referred pain in one or both hips, depending on the location of the ulcer. The severity of symptoms, of course, varies in different patients, and in several instances we have noted more or less of a periodicity of exacerbations and remissions, lasting several weeks and entirely independent of treatment. That this is not due to healing of the ulcers is evident from the fact that the remission occurs with no apparent change in the appearance of the bladder. As is so frequently the case in inflammation of the bladder, premenstrual congestion exaggerates the symptoms. The symptomatology is usually one of long standing, in our series the duration varied from six months to fourteen years, and the average is about four years.

As the result of years of bladder trouble, these patients have been under more or less constant medical attention and are consequently well versed in their urinary findings. As a rule, they report that the urine was found to be normal, but in two of our cases a history of hæmaturia was given. The bleeding is of short duration, lasting only a day or so, and then completely disappears, at least on gross examination.

Microscopic examination of the urine may be normal with the exception of a slight excess of leucocytes and a few red blood-corpuscles. In only two of our cases were many leucocytes reported. One case came to us with macroscopic hæmaturia which was found to originate in a small ulcer, two others showed a few red blood-cells in the centrifuged specimen, while the remainder showed none. A grossly normal appearing urine with the presence of a few leucocytes and red blood-cells may be said to be characteristic of the majority of these cases.

Etiology—We are at a loss thus far to explain the cause of this condition, but believe with Hunner that it is due to an infection, probably hæmatogenous in origin. The tubercle bacillus is certainly not responsible. In no case has it been demonstrated microscopically nor by guinea-pig inoculation, nor is there anything in the cystoscopic picture or the sections of the bladder suggesting tuberculosis. Hunner seems inclined to ascribe the inflammation to an infection secondary to such a focus as tonsils, teeth, or sinuses, we have made it a special point to determine this possible etiology, but without success. In two of our cases the patients date the onset of symptoms from repeated catheterization, one



FIG 2 — Section of bladder wall showing ulcer at A. Numerous areas of round cell infiltration in submucosa. Edema shown by looseness of muscularis. Only slight increase in connective tissue.

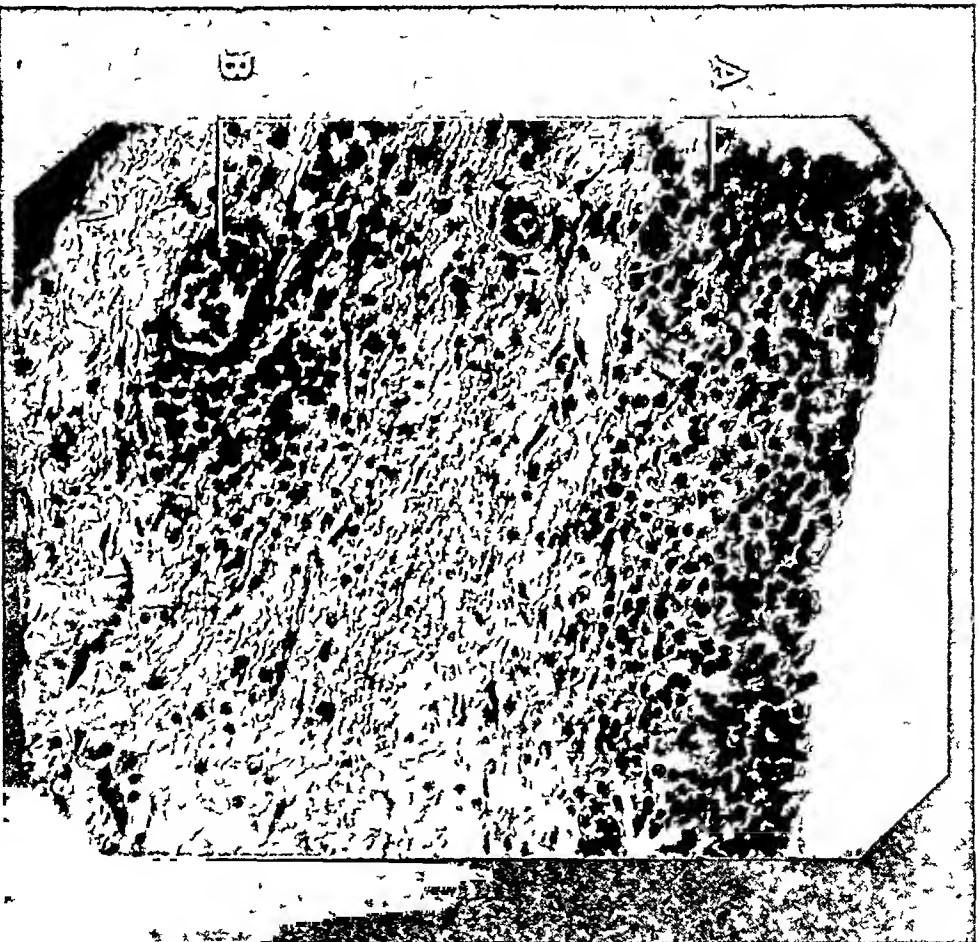


FIG 3 — 1. Mucosa in non ulcerated urea. Infiltration of round cells composed almost entirely of lymphocytes and plasma cells. 2. Blood vessels in submucosa filled with polymorphonuclear leukocytes with perivascular infiltration.

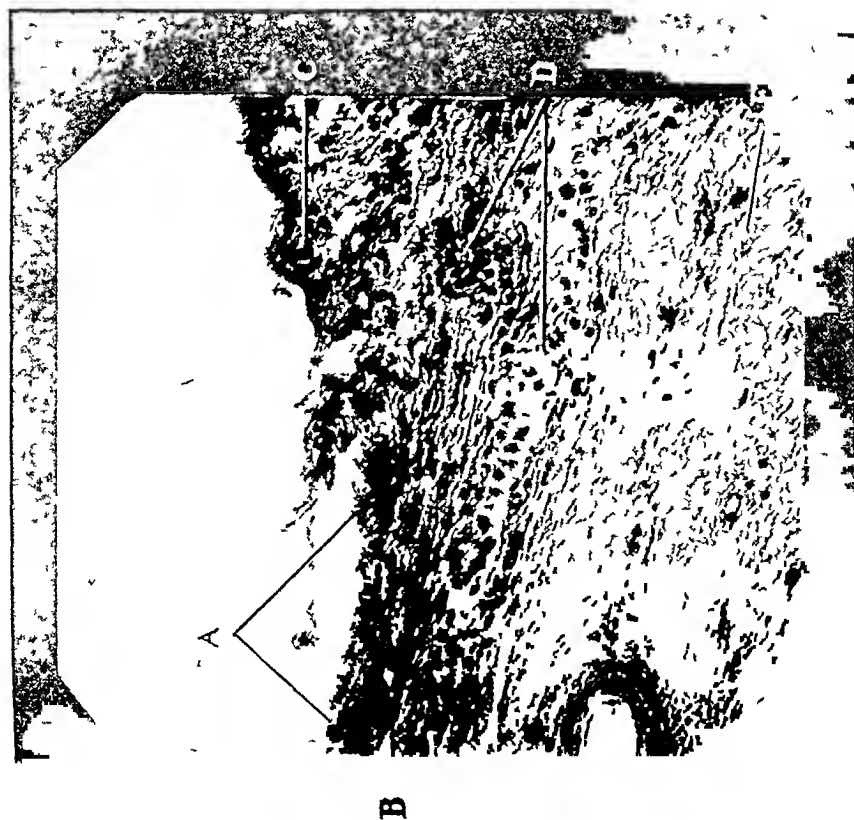


FIG. 4 —A Base of ulcer showing absence of epithelium B Thickened basement membrane C Epithelium at edge of ulcer D Blood vessels filled with leucocytes E Edema of submucosa

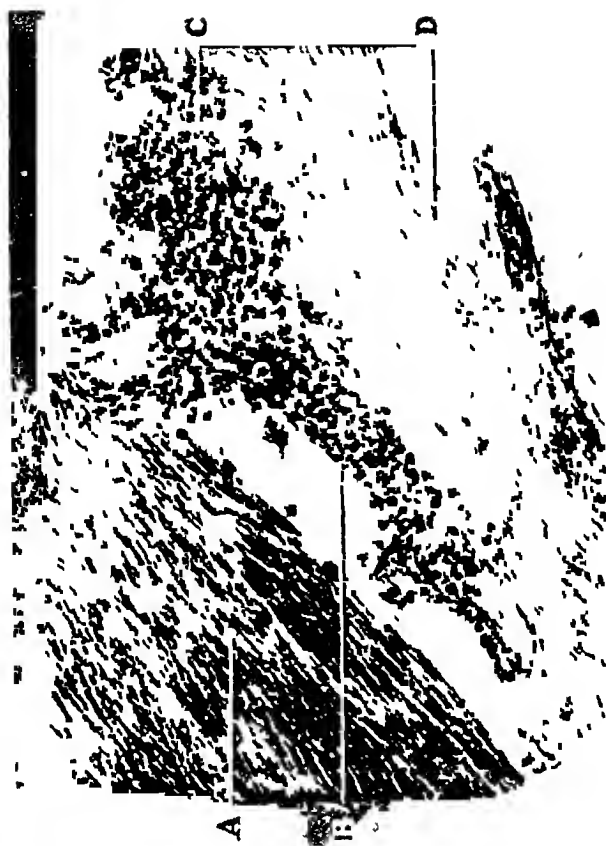


FIG. 5 —Taken from centre of muscular layer A Muscle B Large blood vessels filled with polymorphonuclear leucocytes which can be seen invading vessel wall C Perivascular infiltration D Connective tissue

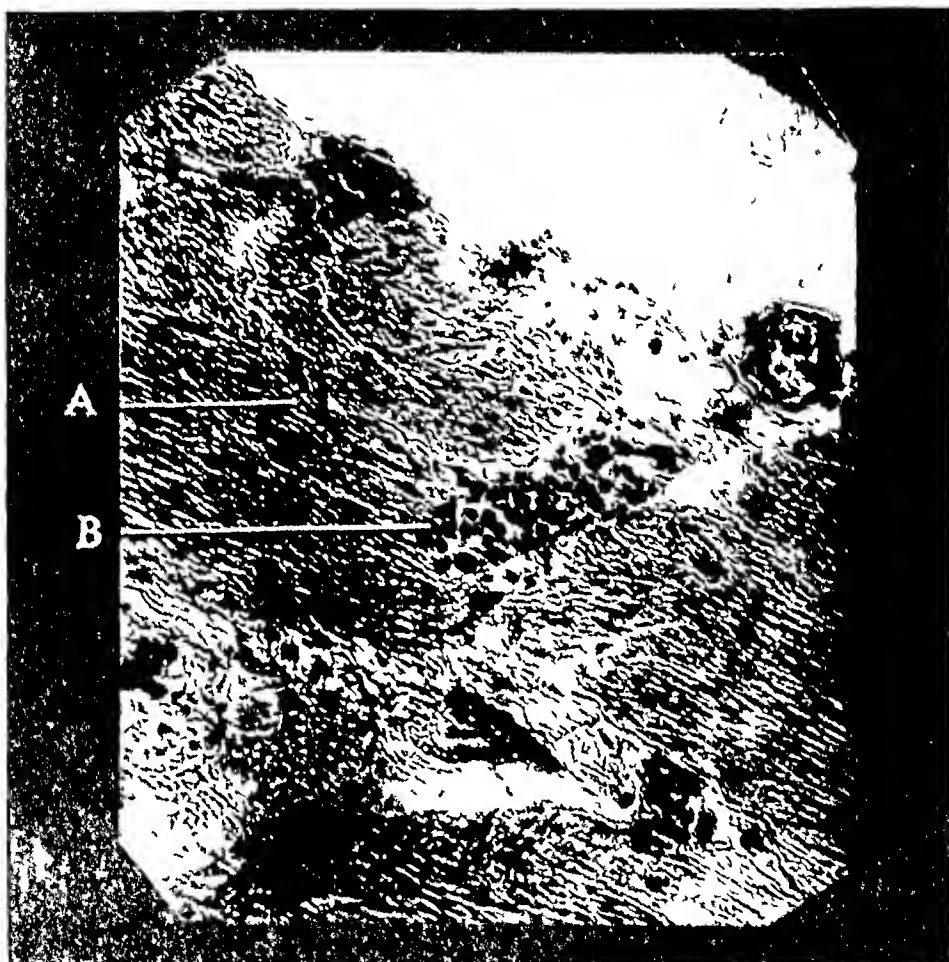


FIG. 6 — taken from fibrous coat of bladder. A Fibrous tissue. B Blood-vessels filled with polymorphonuclear leucocytes which can be seen within the vessel wall. Also perivascular collection of leucocytes.

during an attack of typhoid fever, the other following an operation. The remainder can ascribe no probable cause.

In none of our cases has there been any evidence whatever of a gonococcal infection. The condition is not secondary to inflammatory disease of the pelvic organs, for no such condition has been demonstrated either by vaginal palpation or intra-abdominal examination. From the fact that the pathology is always limited to or is most extensive in the bladder vertex, one might consider the possibility of its being associated with disease of the urachus, but we have found no evidence of this.

Hunner reports a sterile urine in his cases, such has not invariably been our experience. In one there was a pure culture of colon bacilli, in another staphylococci and non-hæmolytic streptococci. In three the urine was sterile, while in the remaining cultures were not made.

An analysis of the clinical and pathological findings suggests the possibility that a paracystitis may be the primary lesion, and that the changes seen in the bladder itself are purely a secondary manifestation.

Treatment—We have run through the gamut of local applications in our treatment of these cases and have come to the conclusion that Hunner is correct in his statement that "no form of treatment will suffice except complete excision of the inflammatory area." As previously stated, certain cases show periods of improvement lasting several weeks, which seem to be in no way dependent on treatment. Again, the symptoms may be somewhat relieved by applications of silver nitrate, silver iodide, carbolic acid, etc., but the relief is only temporary and nothing short of excision has in our hands given a permanent cure. We have not tried fulguration, but Hunner reports two cases in which this treatment produced such severe pain that the patients refused further applications, he has also used the actual cautery wire which seemed to lessen the symptoms somewhat, but did not cause healing of the ulcers.

Operative Treatment—The operation consists in excision of the diseased area of bladder wall, and the limits of excision are determined not by the ulcerations, but by the distinctly outlined œdema. Anything short of this will result in failure.

Through a suprapubic incision, the bladder is exposed and opened, if possible, at a point previously determined by cystoscopic examination to be outside the area of œdema. The opening in the bladder is made sufficiently large to give a good exposure of its interior and the greatest care is exercised in handling the bladder to avoid an artificial œdema incident to trauma. By means of an illuminated vesical retractor, it is an easy matter to determine the limitations of the œdema, and these are marked by a series of linen traction sutures, passed deeply into the bladder wall to prevent their cutting out. Small ulcers which were plainly seen through the cystoscope in a well-distended bladder may at operation be difficult to locate at first glance. They appear as small, red spots which bleed easily on being touched with a cotton-covered probe.

After placing the traction sutures, the bladder is freed as much as necessary and the area outlined by the sutures is excised. Ideally, the operation should be extraperitoneal, but occasionally, in spite of care, the peritoneum will be opened during separation of the bladder, we have seen no ill results follow. After complete hæmostasis has been obtained the bladder is closed with a two-layer suture of catgut, the first being submucous, the second intramuscular, and both of the Cushing type. A suprapubic drain is placed in the bladder through an angle of the incision, and a Mikulicz drain is placed in the prevesical space, well away from the suture line in the bladder wall.

Post-operative Treatment—The Mikulicz drain is removed in forty-eight hours, the bladder drain at the end of ten days. The bladder is irrigated daily through the drain, with a catheter in the urethra to avoid the danger of over-distention. After removal of the tube we have found it advisable to continue the bladder irrigation, using a weak silver solution, until the healing is complete. The patient is instructed to retain the urine as long as possible in order to hasten the restoration of the bladder to its normal capacity, which requires, as a rule, about two months.

Results—Eight of our cases have been operated upon, one by Doctor Hunner and seven by Doctor Clark. In all of these, various methods of treatment were tried and in none was more than a temporary lessening of symptoms obtained.

The first case, who had been under our care for some time, consulted Doctor Hunner, who operated upon her two years and a half ago, this patient is cured after many years of intense bladder symptoms. The time since operation in our cases is as follows: Case I, two and one-half years, Case II, two years, Case III, twenty-three months, Case IV, twenty-one months, Case V, sixteen months, Case VI, nine months, Case VII, three months, Case VIII, two months. We have followed the post-operative course of these patients very carefully and have a written or verbal report of all up to date. Seven have been cured, and in each the bladder capacity has been restored to normal. Case II had a urinary fistula at the site of the suprapubic drain for several months, but this has closed and the patient is now free from bladder symptoms. Case III was well for seven months when the symptoms returned during a severe attack of influenza. She has a recurrence of the œdema and ulceration on the left side of the bladder vertex and is returning to the hospital for a second operation.

In no series of cases that we have studied has greater appreciation of what an operation has done for them been shown than in the seven who have been cured. We have recently had the opportunity of making a cystoscopic examination of four of these patients, and the bladder in each presented a normal appearance with the exception of a thin scar line at the site of excision.

HUNNER'S ULCER OF THE BLADDER

Non-operative Cases—Case IX was examined two years ago on account of severe vesical symptoms. She had a myoma uteri the size of a two months' pregnancy and a typical lesion in the vertex of the bladder, with marked œdema and a single ulcer located in the median line, one inch posterior to the internal sphincter. She later consulted a surgeon in a neighboring city, who ignored the bladder findings and ascribed her symptoms to pressure of the tumor. A hysterectomy was performed, and at our last report there has been no relief of the urinary symptoms.

Case X has only recently been under observation. She was admitted to the hospital complaining of frequency and urgency of urination, with pain low down in the left side of the abdomen, referred to the left hip. On cystoscopic examination, œdema of the left bladder vertex was found, with an ulcer situated one inch to the left and one inch behind the left ureteral orifice, which is the first instance in our experience of ulceration near the base. Under confinement in bed and silver nitrate applications, the symptoms lessened, but the ulcer remained the same. Contrary to advice, she insisted on going home, and in a recent letter from her physician we learn that the symptoms have recurred with such severity that she desires to return for operation.

Summary—1. Circumscribed pan-mural ulcerative cystitis is a distinct pathologic entity, characterized clinically by its chronicity, intense vesical symptoms, and a urine, usually sterile, containing a slight excess of leucocytes and a few red blood-cells, pathologically, by its location in the vertex of the bladder, presenting a sharply demarcated area of œdema with one or more small, superficial ulcers within this œdematous area. The inflammation affects the entire bladder wall and may involve the adjacent peritoneum.

2. The etiology is as yet undetermined, but it is probably due to infection of hæmatogenous origin.

3. Intravesical applications are of value only in giving partial and temporary relief. The best method of treatment consists in excision of the diseased bladder wall, the limits of which are determined by the extent of the œdema.

HYPOSPADIAS, WITH PARTICULAR REFERENCE TO THE OPERATION OF BUCKNALL

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It is the purpose of this article to report a case of peno-scrotal hypospadias cured by the operation of Bucknall,¹ and to bring to the attention of surgeons an operative procedure which—if we are to judge by all absence of mention of it in one of the most recent and authoritative text-books of genito-urinary surgery—has not received the recognition which its surgical soundness warrants.

The difficult problem involved in the treatment of hypospadias is essentially a problem of plastic surgery, and in an examination of the procedures hitherto devised one is more impressed by their ingenuity than by their agreement with the well-recognized principles on which this type of operation should be based.

The operations employed for the treatment of hypospadias may be briefly described as follows:

1 OPERATION OF NOVÉ-JOSSERAND *First Stage* (a) Perineal urethrotomy (b) Excision of urethral opening in the peno-scrotal region and closure by suture *Second Stage* Tunnelling of skin of penis from the urethrotomy orifice to the glans, and insertion of a free skin graft from the thigh which has been sutured into tubal form around a staff *Third Stage* Closure of perineal urethrotomy, if necessary

2 OPERATION OF ROCHET Identical with the operation of Nove-Josserand, except that a skin flap, swung up from the scrotum, is used to form the new urethra, instead of a free skin graft from the thigh

3 OPERATION OF DUPLAY *First Stage* (a) Perineal urethrotomy (b) Two skin flaps are dissected up, one on each side of the urethra, and sewn together over a catheter, to form the new urethra (c) The raw areas are covered with two skin flaps raised from the skin of the ventral surface of the penis *Second Stage* Closure of perineal urethrotomy when spontaneous closure does not occur

4 OPERATION OF BECK (a) Skin flaps dissected up and sewn together as in the Duplay operation (b) Raw surface covered by a skin flap rotated into position from the scrotum

5 OPERATION OF WOOD *First Stage* (a) Perineal urethrotomy (b) Raw edges made by two parallel incisions lateral to the urethra, a skin flap turned up from the scrotum and sutured to these raw edges, thus forming a new urethral tube *Second Stage* Closure of perineal urethrotomy, if necessary

¹ Lancet Sept. 28, 1907, p. 887

6 OPERATION OF ROSENBERGER *First Stage* (a) Perineal urethrotomy (b) Raw areas made by two incisions, one on each side of the urethra, these raw areas sutured to skin edges made by suitable incisions in the skin of the abdomen *Second Stage* After healing between the penis and the strip of abdominal skin has occurred, the abdominal flap is dissected free *Third Stage* Closure of perineal urethrotomy, if necessary

7 OPERATION OF LAUDERER AND BIDDER *First Stage* (a) Perineal urethrotomy (b) Denudation of each side of urethra (c) Corresponding denudations in skin of scrotum (d) Penis flexed onto scrotum and cut edges, lateral to the urethra, sutured to corresponding cut edges in scrotal skin *Second Stage* After healing of penis to scrotum has occurred, the penis is dissected free and the raw area in the scrotum covered by suturing *Third Stage* Closure of perineal urethrotomy, if necessary

8 OPERATION OF BOUISSON A flap is turned up from the scrotal skin sufficiently long to double on itself and thus form the floor of the new urethra, consisting of two thicknesses of skin

9 OPERATION OF MOUTET (a) A flap of scrotal skin is turned up to form the roof of the new urethra (b) This is covered by a flap turned down from the pubis to form the floor of the new urethra

10 OPERATION OF MAYO *First Stage* According to the principle of Van Hook a urethral tube is constructed from the redundant preputial skin, swung around on a pedicle, and tunnelled into place *Second Stage* After ten days a perineal urethrotomy is done, the pedicle of the skin flap divided, and the ends of the two urethras sutured *Third Stage* Perineal urethrotomy closed, if necessary

11 OPERATION OF HAMILTON RUSSELL Ingenious "clergyman's stole" incision by which narrow flaps are provided from the penile skin and are sutured to form a new urethra A suprapubic cystostomy is done and the peno-scrotal opening of the hypospadias closed

12 TRANSPLANTATION OPERATIONS *Heteroplastic* (a) Transplantation of urethra of animals (b) Transplantation of ureter of animals (c) Transplantation of vein of animals *Homoplastic* (d) Transplantation of urethra of cadaver—ureter of cadaver—vein of cadaver *Autoplastic* (e) Transplantation of vein from the individual

It is not easy to determine what percentage of success has attended these operations, as occasional successes are more likely to be reported than repeated failures and analyses of large series of cases are rare It is notorious, however, that the general attitude of surgeons, as regards this deformity, is one of pessimism, and the statistical analyses which do exist hardly justify the enthusiasm which the occasional (perhaps unfortunate) success of an unsound operation seemed to warrant

If one scrutinizes these operative procedures by the criteria of sound plastic surgery not one of them meets the tests These well-established principles are as follows

1 *In every plastic operation there is an element of chance, the possibility*

of complete failure should always be taken into consideration and the question asked whether, in case this occurs, the patient will be worse off than before In many plastics (the cure of simple harelip, for example) the chance of complete failure is so slight as to be negligible, in others (for example, exstrophy of the bladder) the condition is so distressing and carries such a threat to life that one is justified in taking large chances. Peno-scrotal hypospadias has no place in the former class, it does not quite belong in the latter.

2 *Plastic operations should be devised so that broad surfaces, rather than cut edges, are approximated* This requirement is often impossible to meet, but the great success of the imbrication operation for inguinal hernia illustrates what may be accomplished in the repair of large defects (even when the material at hand appears inadequate) if the operation used is sound in this fundamental principle.

3 *Tension must be avoided at all stages* Sutures should be used not to drag tissues together, but to tack them in position. Fine suture material should therefore be chosen which will break if strain is put upon it.

4 *Circulation of flaps must be reasonably preserved*

5 *Flaps must be held in position without the use of elaborate retention dressings* These are seldom efficient and therefore give a false sense of security. When not efficient they are usually harmful.

6 *The repair of the actual defect should be done in one stage*, operative difficulties are always greater at the second than at the first stage. If a second stage operation is needed, it should be for purposes of reinforcement and not, therefore, really an essential part of the plastic.

7 *The purpose of a plastic is the permanent and not the temporary result* Flaps should, therefore, be devised to allow for contracture, and ultimate success planned for, even at the expense of neatness in the immediate result. The importance of this principle is well illustrated in the operation for simple harelip. A practically perfect immediate result is quite easy to obtain, but the shortened upper lip and dimple which so often develop later might have been avoided if the flaps had been more generously cut and the surgeon contented with a "lumpy" immediate result.

8 *The probability of success in a plastic is always greatest, other things being equal, if infection is absent* Yet it is striking that some of the most brilliant successes are obtained with considerable constancy in regions of the body where infection is necessarily present. The primary healing which occurs after extensive resections of the lower lip and the practically invisible scar which often results, illustrate the possibilities of plastic surgery even when infection cannot be excluded.

It is clear that only rarely can all these requirements be met. The imbrication operation for hernia is, indeed, one of the few plastic operations which are sound in every respect. It is equally clear that success in this field has often been achieved by operations whose fundamental principles are open to criticism. This is certainly true of the operations for

hypospadias Yet an examination of these procedures, as to their surgical soundness, will emphasize the great superiority of the Bucknall operation and justify the hope that by its use the results of the treatment of hypospadias will be improved

1 *Operation of Nové-Josseland*—The whole success of the operation depends on the take of a free skin graft, applied in an infected region and in a position where complete rest (essential to the success of a graft) can neither be obtained nor approached Success by this method would be a lucky chance Similar criticism must be made of the *Operation of Rochet*

2 *Operation of Duplay*—Burghard has stated the case correctly This operation "so simple and apparently satisfactory on paper is practically useless, the parts are too small and the tissues are not sufficiently abundant It is often difficult to draw the flaps together without strangulating the penis and some amount of sloughing is quite common"

3 *Operation of Beck*—The formation of the urethral tube depends on the healing of cut edges rather than flat surfaces, the skin used for this tube is disturbed by dissection and usually drawn together under tension, the rotation of a rather long scrotal skin flap with a small pedicle is a bad feature

4 *Operation of Wood*—The skin flap is badly devised

5 *Operation of Rosenberger*—A good principle is suggested, but the practical difficulties are great

6 *Operation of Laucler and Ridder*—This operation is correct in principle, there is no unnecessary dissection, no flaps are used, tension is avoided, the parts are approximated in unforced position The sound idea on which it is based is adopted by Bucknall, but very greatly improved

8 *Operation of Bouisson*—Thoroughly unsound in every particular

9 *Operation of Moutet*—Essentially a flap operation and the flaps are not well devised Moutet's account of the result in his own case is as follows "The pubic flap sloughed entirely, the scrotal flap failed to heal", "failure was complete"

10 *Operation of Mayo*—The success of the operation depends entirely on the viability of a long flap swung into unnatural position Even if this lives the operation is a failure unless the suture of the ends of the two urethras, made at a second stage, also heals

11 *Operation of Hamilton Russell*—Ingenious but unsound

12 *Transplantations*—The objections to heteroplastic and homoplastic grafts are well known, one can only regard the occasional success of *any* free graft, placed in a position where neither the crudest cleanliness nor immobility can be obtained, as a lucky chance

The operation of Bucknall consists of the following steps

1 *Correction of the curvature* of the penis, if this is indicated, is made in the usual manner A sufficient period of time is allowed to elapse (not less than three months) before the cure of the hypospadias is undertaken

2 *The Plastic Operation*—(a) The penis is laid back on the pubis and two parallel incisions ($\frac{1}{4}$ inch apart) are made in the skin on the ventral surface of penis and scrotum, these incisions are prolonged laterally at either end by small incisions, about $\frac{1}{4}$ inch in length, made at right angles to them (Fig 1, *a* and *b*) I have found it convenient to place four traction sutures at *c*, *d*, *e*, and *f*

(b) Two lateral flaps are dissected up, leaving the median strip of skin untouched (Fig 2) This strip will form the new urethra, the penile portion (marked "*a*") its roof, and the scrotal portion (marked "*b*") its floor Each lateral flap should be about $\frac{1}{4}$ inch wide and the median strip the same width

(c) The penis is flexed onto the scrotum with the hypospadiac opening as a hinge, the lateral skin flaps are thus brought into flat approxi-

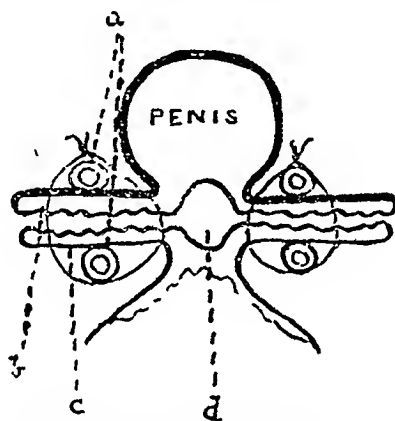


FIG 5—Schematic cross section showing the result of the first stage of the operation (after Bucknall)
a, rubber tubes, *b*, lateral skin flap, penile portion, *c*, lateral skin flap, scrotal portion, *d*, new urethra

mation with each other, like the leaves of a closed book, and in this position mattress sutures are applied, as shown, Fig 3 These sutures are tied over small rubber tubes, one of which is represented (Fig 3, *a*) by a dotted line, the corresponding tube on the lower flap being omitted for sake of clearness The method of applying the sutures to produce approximation of the median skin flaps without having them penetrate the new urethral tube is shown in Fig 4 The finest suture material should be used and a No 6 catheter inserted and fastened to the glans with a stay stitch The catheter should be inserted before the mattress sutures have been applied, it is omitted from the illustration for the sake of clearness The relations after completion of this stage of the operation are shown in the schematic cross-section represented in Fig 5 No dressing should be used A chloroform mask, suspended from a gauze bandage around the waist, with the bell of the mask lying over the scrotum, provides the best protection from the bed-clothes Bromides should be given for pain and to prevent erections The end of the catheter should be allowed to lie in a urinal containing

FIG 1

FIG 2

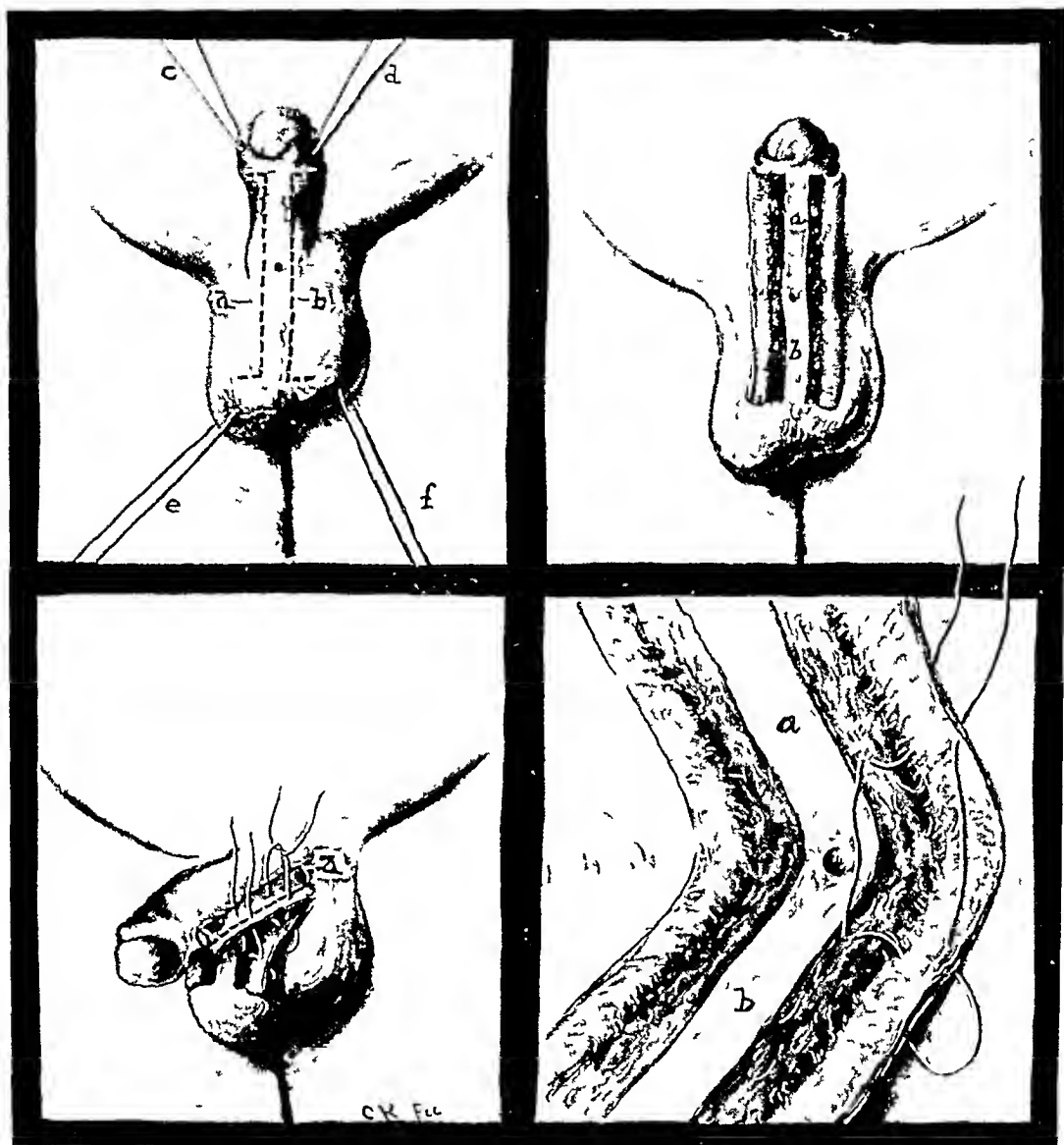


FIG 3

FIG 4

FIG 1 —The first incisions are represented by dotted lines (a and b) Stay sutures hold the penis and scrotum in place (c d e f)

FIG 2 —Lateral skin flaps have been dissected up A central strip of skin remains of which the upper or penile portion (a) will form the roof the lower or scrotal portion (b) the floor of the new urethra

FIG 3 —The penis has been flexed with the hypospadias opening as a hinge and the lateral flaps are being sutured over rubber tubes, one of these tubes is represented by the dotted line (a) the corresponding rubber tube on the lower flap is omitted for purposes of clearness

FIG 4 —An enlarged drawing showing the way the suture is laid so as to approximate the skin edges (for the formation of the new urethral tube) without penetrating them a penile skin, b the scrotal

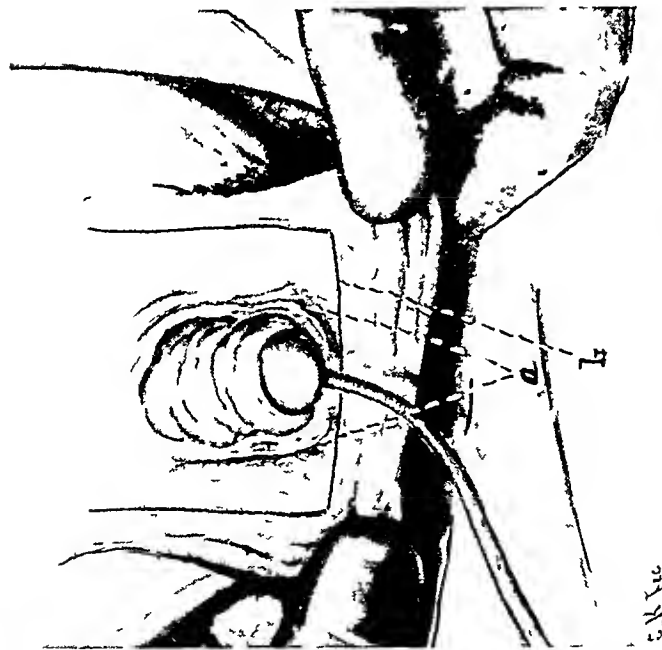


FIG 6—First step in the second stage operation. The penis has healed in the scrotal bed the edges of the lateral skin flap are seen at *a*. The skin incision is shown at *b* it is purposely represented as made further from the penis than is necessary in order to indicate that one should err on the side of lifting up too large rather than too small a flap. A rubber catheter has been inserted in the urethra in order to protect it during the dissection of the penis from the scrotum

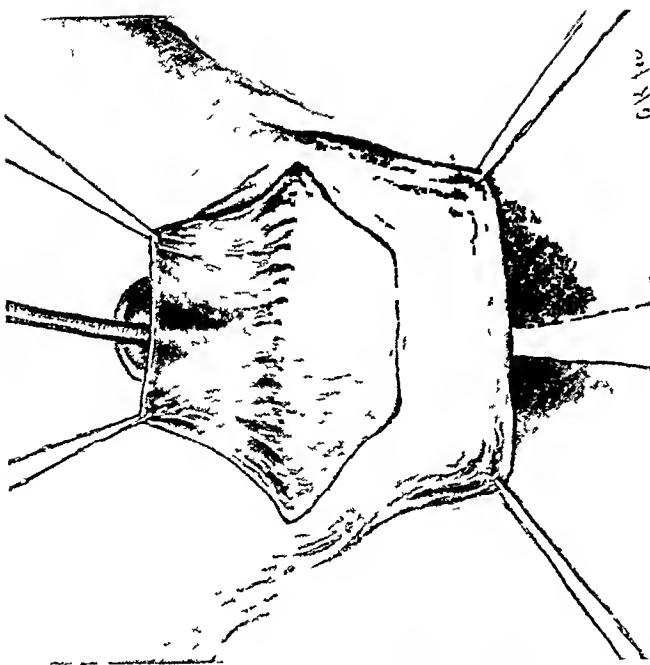


FIG 7—The dissection of penis from scrotum has been completed, the new urethra distended by the catheter, can be seen bulging against the skin flap

FIG 8

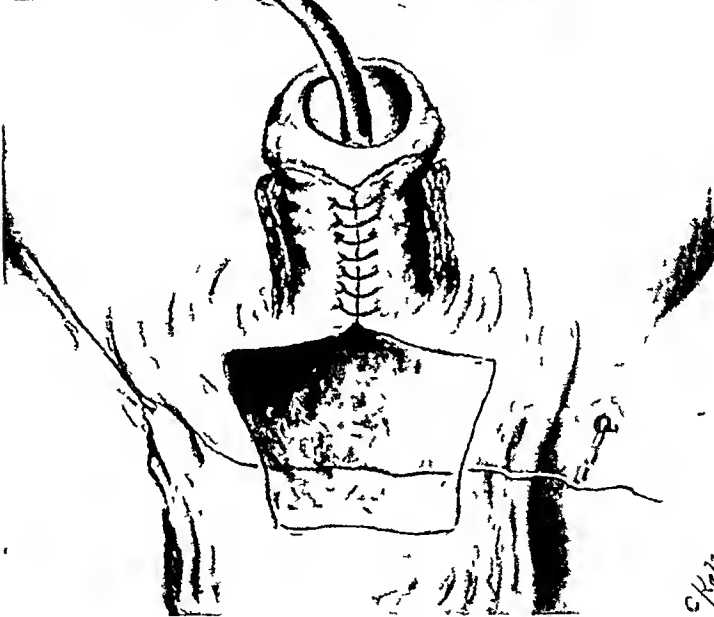
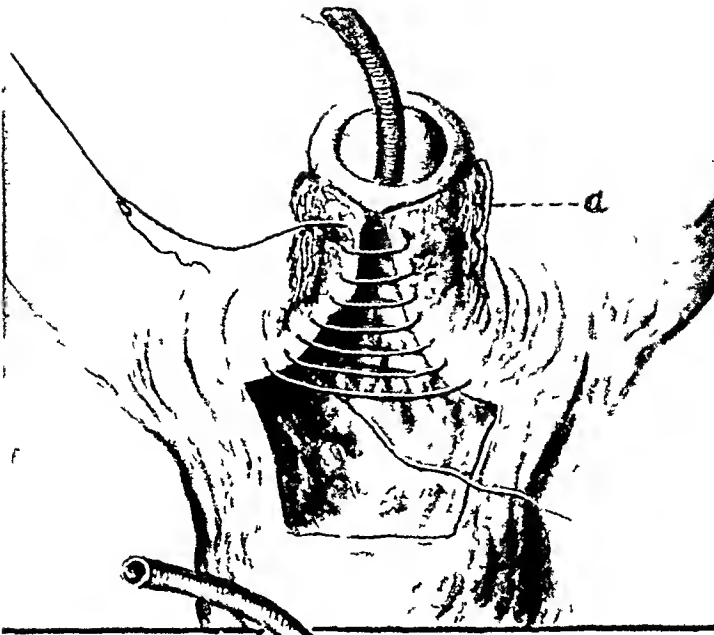


FIG 9

FIG 8—Suture of scrotal flap begun, interrupted and not continuous suture (as shown by the artist) should be used *a*, cutaneous wings formed by the healing of the two lateral skin flaps sutured at the first operation

FIG 9—Suture of scrotal flap completed. One suture has been placed beginning the repair of the defect in the scrotum

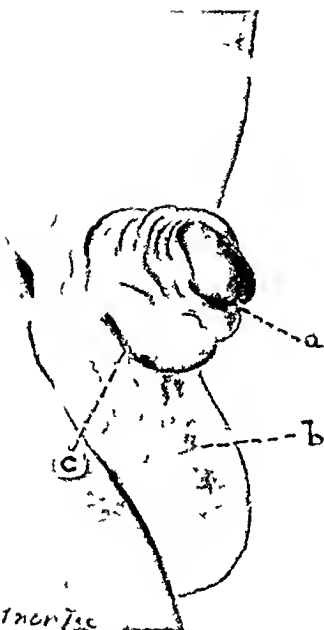


FIG. 11.—Final result. *a* present urethral orifice. *b* scar in scrotum at site of area from which scrotal flap was raised. *c* site of previous urethral orifice (at peno-scrotal junction). From a cosmetic point of view the result is lumpy because all redundant skin has purposely been left for future plastics. From a functional point of view the result is perfect.

boric acid solution The catheter should be removed on the fifth day and alternate stitches on the same day, the remaining stitches may be removed a few days later When healing has occurred between the lateral skin flaps, which have been sutured in flat approximation, the penis is fixed to the scrotum, the hypospadiac opening is closed and a new cutaneous urethra has been formed which now opens near the glans (Fig 6)

(d) The second stage of the operation is not undertaken to complete the cure of the hypospadias, which has been accomplished by the first stage, but to restore the penis to its normal position and to cover raw areas It should be undertaken not sooner than twenty-one days after the first operation, it should not be considered until healing from the first operation is absolutely complete, no matter how long this takes Indeed, it is probably wise to discharge the patient from the hospital for a period of two or three weeks, rather than be tempted to intervene too

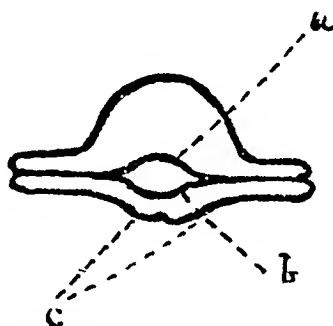


FIG 10 —Schematic cross section to show the final result *a*, roof of urethra formed of penile skin, *b*, floor of urethra, formed of scrotal skin, *c*, reflected scrotal skin flap

soon The skin incision is made as shown in Fig 6, *b*, though not so far out on the scrotum as represented in the illustration, this feature is purposely exaggerated in order to emphasize the fact that abundant skin should be taken (more will be needed than on first thought seems necessary), and that as much skin as desired may, with impunity, be lifted up from the scrotal redundancy A catheter should be inserted before the dissection is begun, to protect the urethra from injury, and the dissection carried out as shown in Fig 7 The edges of this skin flap are sutured as shown in Fig 8, except that interrupted sutures should be used, rather than a continuous one, as illustrated The result, after these interrupted sutures are tied, is shown in Fig 9

The raw area in the scrotum is covered by means of a few sutures placed as shown at *a*, Fig 9 No retention catheter is needed A cross-section of the penis at the end of the operation is schematically represented in Fig 10, the method of formation of the new urethra from penile and scrotal skin may here be clearly seen

The patient treated by this operation was a boy four and one-half years of age, of active mind and sensitive nature, whose morale

was beginning to be undermined by the humiliation of abnormal urination. The functional result was a complete success, when the patient left the hospital he was able to void in the normal manner and to project a good stream. The cosmetic result (Fig 11) is intentionally "lumpy," as all redundant skin was purposely left, against the needs of possible future plastics. It would, of course, have been quite simple to trim up the skin and improve appearances. I did not undertake to bring the urethral opening out of the glans, the vital part of the operation is to advance the opening from the perineum to the region of the glans. If this is accomplished, the relatively simple glandular operation can be done later, if for cosmetic or other reasons this seems advisable.

The simple and entirely sound operation of Bucknall should not be complicated by attempts at cosmetics until the real purpose of the operation (the cure of the hypospadias) has been achieved.

PROJECTILE FRACTURES OF LONG BONES

A COMPARATIVE MECHANICAL STUDY

BY KELLOGG SPEED, M D.

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IN the handling of many hundreds of gunshot fractures, glancing hastily at times at an X-ray plate to note the presence or absence of foreign bodies, it always has been my intention to study these lesions so that they could be reduced to simple terms. The comminution present made many skiagrams appear as bone hash, but these severe fragmentation fractures are really exceptional.

To understand the mechanism of fracture—by that is meant the everyday closed fracture of civil life—we must consider bone from a physical standpoint. For study we can take any long bone as an example, because they are the most concerned, the skull alone excepted. Certain physical properties of long bones must be kept in mind. Bones possess elasticity, strength and toughness, and are governed by the same physical laws as similar supporting substances subjected to stress and strain.

In long bones it has been proved that the compacta or hard shell is intended to furnish rigidity and form, while the cancellous inner and terminal portions possess much greater strength to resist forces applied at any given point in the normal axis of the supporting trabeculae. For example, the condyles of the femur or the os calcis, both of which bear much of the jar and stress of weight bearing, are composed of a delicate cancellous bone with an egg-shell compacta on the outer surface. If force is applied in the normal direction of weight bearing or muscle pull, this cancellous bone will withstand enormously. Wolff's law, so often forgotten, states that the structure of bone is determined by the internal reaction of the individual bone to the body weight and the stress and strain of muscular activity.

The general mechanism of the ordinary fracture of civil accident must first be understood. When the body suffers any direct trauma a transmission of the stress to the supporting bones results. These stresses or forces can be reduced to simple terms and to two main types—compressional force and torsional force.

First, compression force operating against a long bone acts as pressure does against a rod or beam. If we consider the compression force acting against the bone at a given point, trying to effect a solution of its continuity by crushing in the surface, we must also understand that at a point directly opposite in the line of force, this same power is attempting to tear the bone asunder. That is, the shaft of the bone is being subjected to a compression force at one point, its ends being firmly fixed by attachment to the rest of

the body, and at an opposite point is being split asunder by a force tending to overcome its tensile resistance To simplify, let us call one part of this force compressional, the other tensile It has been determined in the laboratory that a bone shaft will give way to the tensile force sooner than

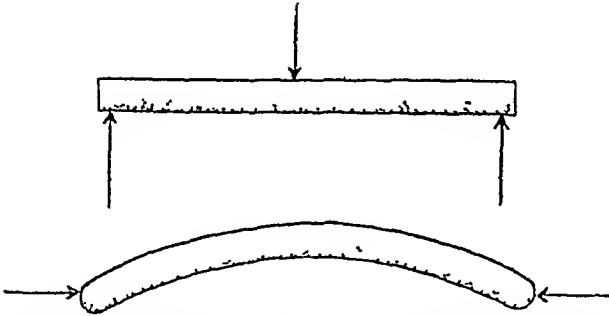


FIG 1—Diagrammatic representation of the two methods of compression of a long bone Upper figure compression the middle acting in the direction of the arrow, bone held by attachments above and below for counter pressure Lower figure force applied in the longitudinal axis leading to bending at center with compression there

to the compressional In fact, a ratio of a bursting compressional force of 3 is required to equal a tensile force of 2

Consequently, when subjected to these forces a bone gives first from the tensile force, especially when there is a relatively slow-acting force which has not much more than sufficient power to break the bone The planes of cleavage, as shown by a line in the skiagram, start on the tensile side, that is the convex side when the bone bends, at a point about opposite the com-

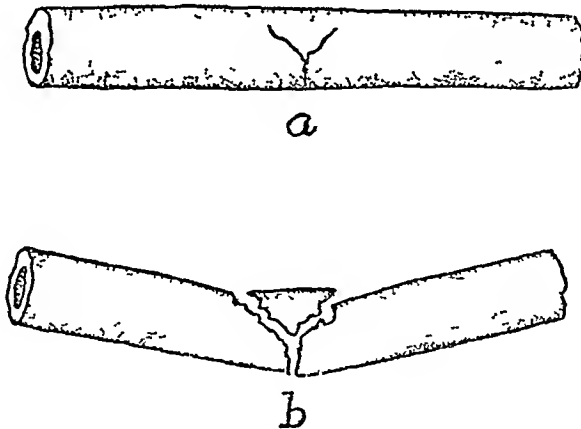


FIG 2—*a* Diagrammatic compression fracture The bone starts to give on the tensile sides, planes of separation diverge as it bends *b*, Resulting fracture with triangular shaped piece broken out on compression side

pression point The bone being somewhat elastic is bent slightly out of its long axis and in giving arches more and more so that these planes of separation tend to assume an oblique direction If two start and assume an opposite direction, we see the breaking out of a triangular-shaped piece

PROJECTILE FRACTURES OF LONG BONES

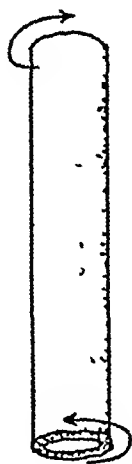


FIG 3 — Illustration of torsion force acting on long bone shaft.

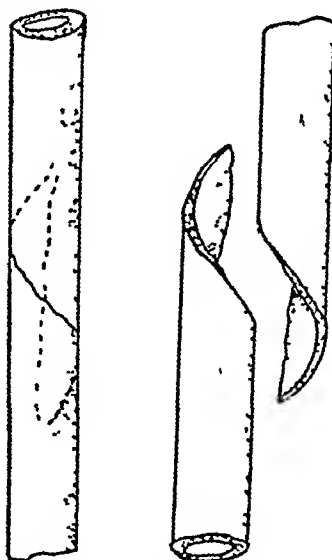


FIG 4 — Unrolling of bone shaft results following torsion violence, spiral fracture

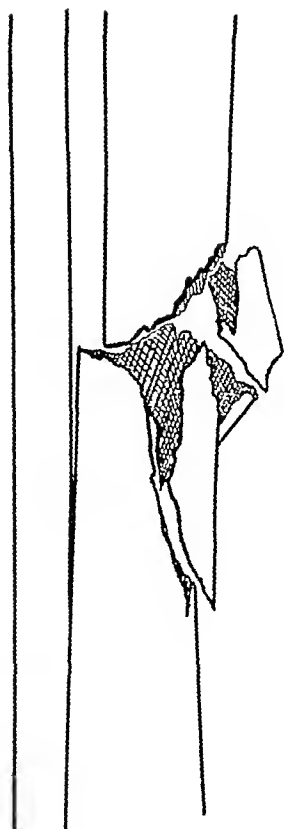


FIG 5 — Tracing of skiagram in compression fracture of the leg. Note the oblique plane of separation and the triangular fragment broken out on the compression side

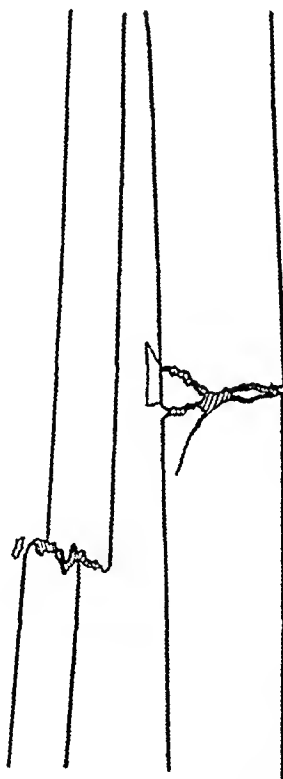


FIG 6 — Compression fracture of both bones of the leg, skiagram tracing. Violence offered on the fibular side

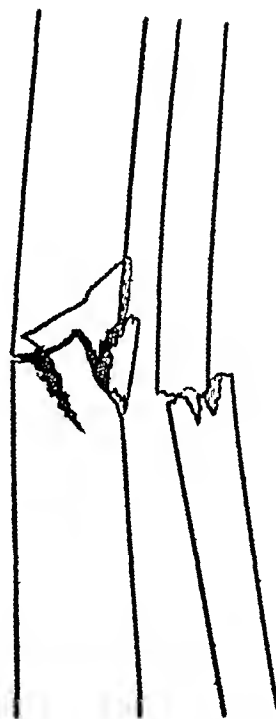


FIG 7 — Similar to FIG 6. Skiagram tracing

of bone on the side of the compression. Only when the compression force is great enough to overcome the bone instantly do we get a transverse line of fracture—the so-called shearing fracture. Any force of less power and of slower action invariably results in an oblique fracture. If the compression is in the longitudinal axis of the bone we may get the same resulting break, or more rarely, longitudinal cracks running up the long axis. These are frequently aided by the various

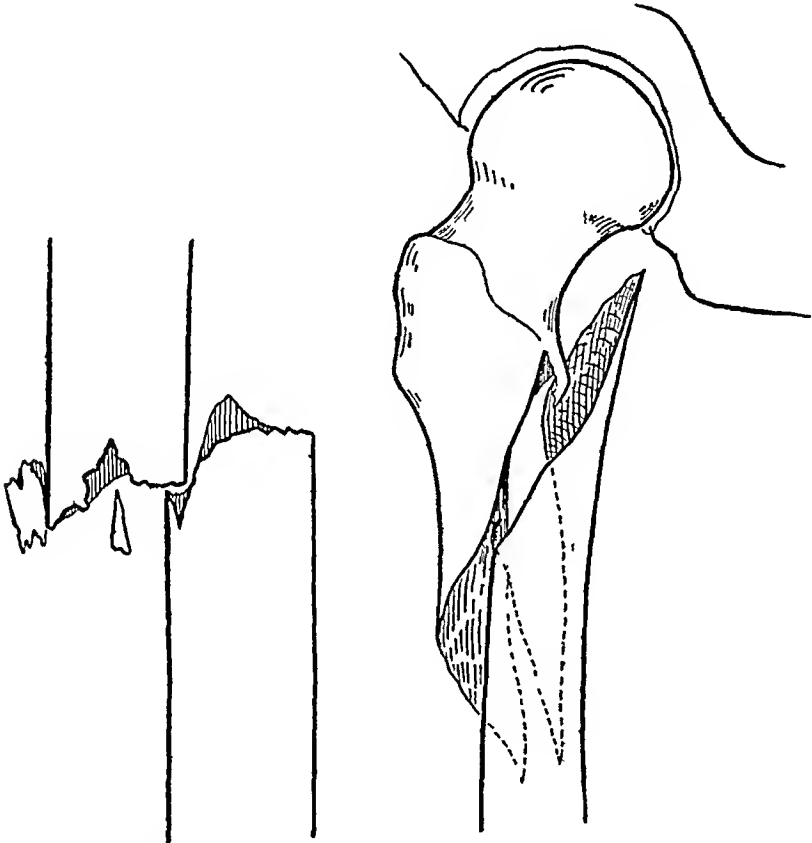


FIG 8—Compression fracture of femur. A quickly acting, ponderous force with almost transverse fracture. Skiagram tracing.

FIG 9—Skiagram tracing spiral fracture of the femur from torsion violence. A glance at a skiagram is sufficient to differentiate the two general types of fracture.

complicating vibrations resulting from the jars of the trauma causing the loss of bone continuity. Buckling and green-stick fractures are also examples of compression fractures.

The second common force in fracture is torsional violence, which results from twisting and affects particularly bones of the extremities. This causes spiral fractures. We find these fractures in the leg and arm when the limb is twisted by being caught in falls or when the body is twisted with the limb fixed. Usually spiral fracture of the leg is caused by the foot being turned violently outward, as in slipping or catching against an object. So regular is this mechanism and so universal the outturning of the foot that

PROJECTILE FRACTURES OF LONG BONES

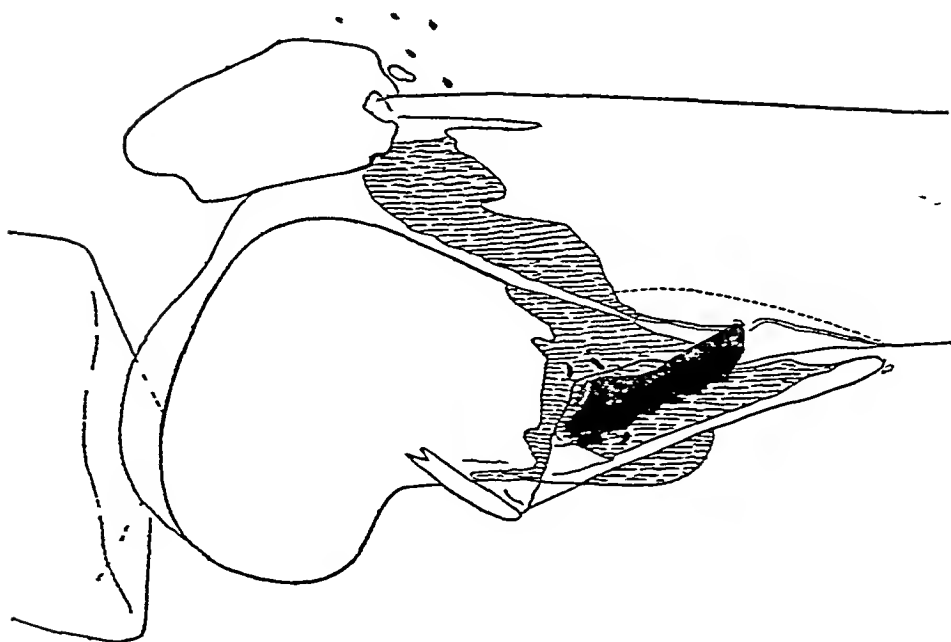


FIG 10—Gunshot fracture of femur from shrapnel. Bone struck on inner lateral surface. Oblique fracture with bone fragment broken out on compression side and turned down.

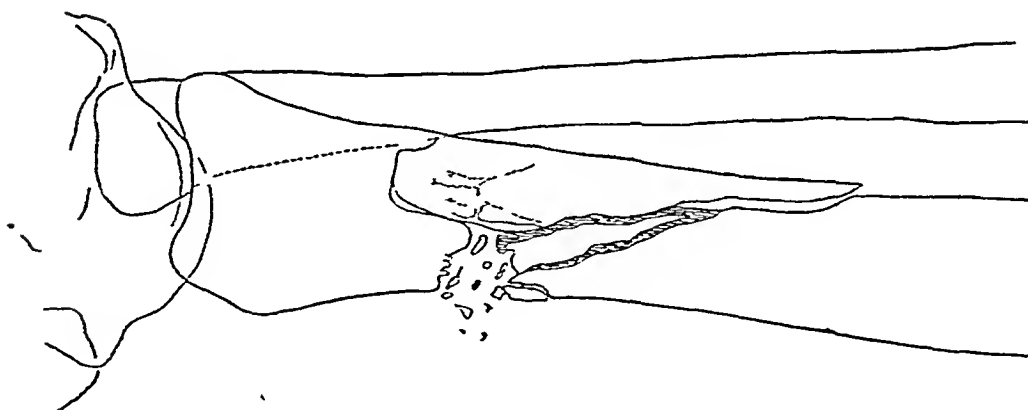


FIG 11—Gunshot fracture of tibia, missile passed out. Purely compression in type with large adherent triangular fragment

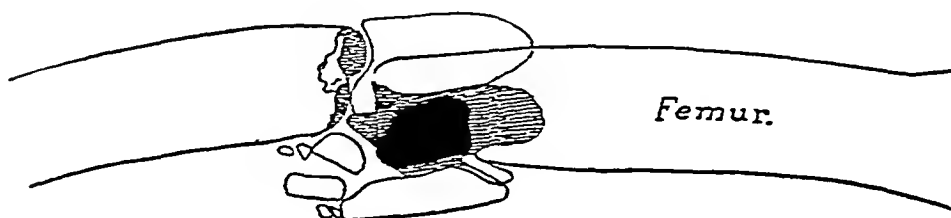


FIG 12—Gunshot fracture of femur, compression by piece of shrapnel which remained in the bone.

we can say that spiral fractures of the right leg are left-handed, that is—they start at a point in the bone and pass downward to the left as a spiral staircase. Likewise, nearly all spiral fractures of the left leg are right-handed. The only exceptions are those in which the leg or foot is fixed and the body is twisted in a direction opposite to the usual mechanism. When torsional violence of sufficient power to cause fracture is applied to long bone, which may be compared to a cylinder, it starts to give at some

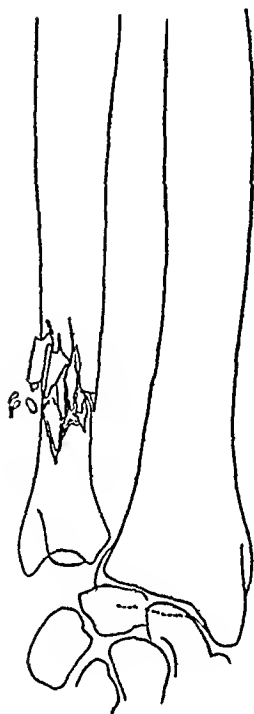


FIG 13—Gunshot fracture of ulna by swiftly moving missile which passed on. Note the greater comminution and smaller fragments a few of which are displaced



FIG 14—Gunshot fracture of humerus. Some metal remains in bone. Low momentum giving large adherent fragments and compression fracture

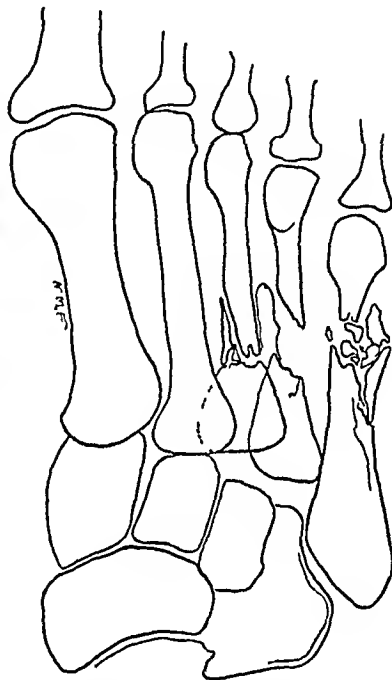


FIG 15—Gunshot fracture of metatarsals. Missile carried on, taking many fragments of fourth bone with its imparted velocity

point on the surface and unrolls in its continuity. The sharp-pointed ends of the fragments are found on the same surface of the bone.

It is true that every fracture will not submit to such simple physical analysis—because there are certain other factors which enter and spoil the pure types of either compression or spiral fracture. There may be flexion of a limb by doubling under—the man falls as the bone gives way—or there may be a change in the line of support of body weight, or frequently there are added rapid vibrations and jars of the body and limb incidental to the trauma. These may complicate the planes of bone separation, but it is surprising what a large percentage of fractures yield to this simple analysis. The time will come I hope when we will all appreciate these con-

PROJECTILE FRACTURES OF LONG BONES

ditions and after examination of X-ray plates in a given case can tell something of the cause. It may influence our nomenclature, furnishing one based on mechanics.

The application of these points to gunshot or projectile fracture seems

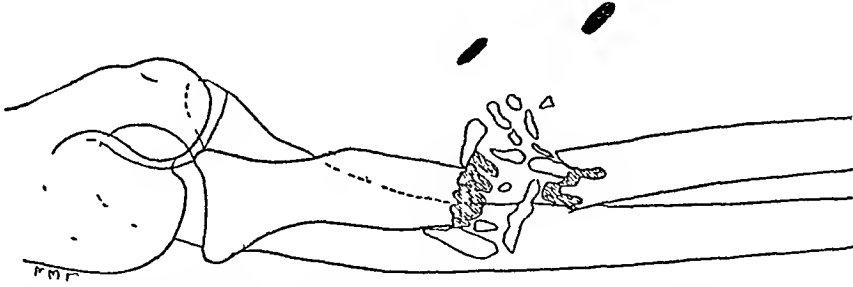


FIG 16—Gunshot fracture of radius. Shrapnel of fairly high velocity, causing small fragments and some displacement of them, compression fracture.

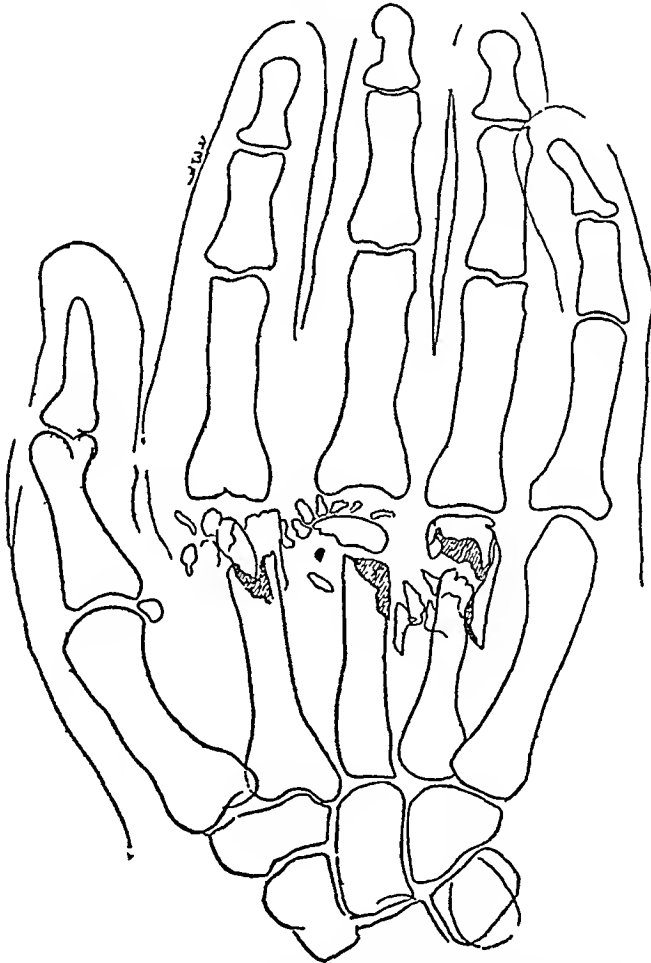


FIG 17—Gunshot fracture metacarpals from 'high velocity bullet'. Note compression fracture comminution, small fragments with displacement.

far fetched. It is not, however, as we can see when we compare the skiagrams of simple civil fractures with those of fractures produced solely by projectiles.

When a man is struck by a bullet or piece of shrapnel in a long bone such as the tibial shaft, what happens? The bone at that point is subjected

to a compressional violence of varying degree depending on the momentum of the projectile. If struck squarely with no angularity we would expect that any resulting fracture of that bone would appear much as a compression fracture in civil life. It does. There is the same oblique or transverse plane of bone separation with frequently a triangular portion broken out on the compression side. This is particularly true if the projectile's velocity has not been great and the total force offered has been just sufficient to cause a break. If the projectile has had a very high velocity it may act as in the case of a conical-nosed bullet—over a very small area, causing puncture, and passing clean through a long bone shaft, leaving a track but with no complete fracture. No pure gunshot fracture then could be a spiral fracture, and none of them are. Sometimes a man falls simultaneously with a gunshot fracture of a limb, which might be twisted, and some spiral character of the bone break might appear, but that rarely happens. If the projectile passes through at high velocity it imparts this velocity to the immediately surrounding bone with which it comes in contact, so that there is more comminution and a wider displacement of the bone fragments. The same rule applies to multiple foreign bodies, as broken-up pieces of shrapnel striking a bone in a small area—there is more comminution.

Gunshot or projectile fracture is then merely compression fracture, sometimes with a wider displacement of loosened fragments. We can agree with Delorme that the dimensions of the fragments in gunshot fracture are inversely proportional to the velocity of the projectile—but will show the result of the mechanism ascribed to compression fracture. Put in another way—the less the velocity of the projectile, the larger the adherent fragments and the smaller their number. With very great projectile velocity there are fewer adherent fragments, but there is a greater total number and they are scattered widely in the track of the projectile, even penetrating into the surrounding soft parts. These small swiftly driven bone particles may break out of the limb through orifices they make themselves, probably taking on some of the rotatory motion from bullets fired by rifled guns. Such fractures result in loss of substances from the bone's continuity.

Any clinical division of gunshot fractures such as "fracture with loss of substance," "fracture with comminution and wide fragmentary separation," "perforation fracture," "gutter fracture" and "contact fracture" simply leads to confusion. They can be called compression fracture, and the description of the displacement of fragments can be added

A FORM OF SPLINT AVAILABLE IN THE TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR

By HARVEY C MASLAND, M D

OF PHILADELPHIA, PA

FRACTURES of the neck of the femur occur most commonly in elderly persons. They frequently arise from a comparatively light traumatism, and indicate thereby a lowered vitality and structural weakening of the part. Experience has taught that these patients bear confinement in bed and the presence of cumbersome dressings very badly.

Probably most surgeons treat these cases with sand bags and extension. Imperfect rigidity of the parts is thus obtained.

Plaster bandages enclosing more or less of the trunk and the thigh are used by many. This dressing looks good from a superficial standpoint, but it is worth while to consider some features that would demonstrate it to be an unsafe procedure in practice. To apply a cast to the trunk, the patient must be upright or else horizontal and supported at the pelvis and the shoulder blades. Of course, the latter position is chosen in fracture of the femur neck. In each of these positions the soft tissues, and to a less extent the skeleton, assume a different conformity and relation to each other. Both of these relations are quite different from the outlines assumed when the patient is recumbent on a bed supporting the weight of his body along the full extent of the trunk. In an obese person this is obvious. Further, we must not overlook that the vertebrae are sagging in the middle while the body is on a two-point suspension with the spines projecting more than they naturally do. Even though the cast has been carefully and expertly applied, it fixes the tissues in a relation not normal to any lateral supine or erect position the patient may subsequently assume. This factor is of more moment in an aged person and explains the great discomfort frequently experienced, and the fact that bedsores are not uncommon.

I was prompted to devise the splint here described to meet an emergency last summer. The patient was a woman seventy-four years of age and weighing 250 pounds. For three days I used sand bags and extension. She complained bitterly of pain in the joint and the back. She could not sleep. There was an erythema over the sacrum due, however, to pressure from an improperly adjusted vent in the fracture bed. My thought was to devise a splint that would hold the thigh rigid to the pelvis, give extension, and at the same time allow some change of position and opportunity to care for the back. A splint with straight sides as in the ordinary Thomas splint can hardly be prevented from turning sidewise. It occurred to me that following the contour of the trunk and

the limb, the changing curves would prevent this turning. An arm up the back, as in the long Thomas splint, did not appeal, because of the objectionable back pressure and because I doubted that the same degree of rigidity could be secured.

The trunk and limb were placed in the position to be made permanent. A tape line was extended parallel to the trunk line from the axilla to 8 inches beyond the foot. A ruler at right angles to the tape line gave the distances at intervals of 2 inches on the tape line to the opposing side of the body. At the pubis the distances to the inner side of the limb were also started and noted with the distances to the outer side. Marking a straight line on the floor these distances were measured off. Drawing a line through these points gave me the contour of the trunk and both sides of the limb, while the patient was in her natural recumbent position.

Using ordinary bale strap iron I bent it to conform to the line of the trunk and the outer side of the limb. Extending about 8 inches beyond the foot the iron was bent back and made to conform to the curve of the inner side of the limb.

At the pubis a cross-section of the thigh is roughly elliptical. The depth of the thigh was noted. At the axilla and waist line holes were drilled in the iron and pieces of flexible tin about 20 inches long and $1\frac{1}{2}$ inches wide were riveted on, thus giving arms about 10 inches long. Holes were also drilled for riveting on the perineal ring. This ring is roughly elliptical with the lower side flattened more than the upper (Fig 1).

The iron was padded. To prevent soiling of the ring from urine I covered it with Dura leather strips laced on through eyes made for the purpose.

I fashioned this iron in less than an hour's time. With the measurements any instrument maker, machinist, or blacksmith could produce it quickly. The artificial leather makes a neat appearance. In some parts it could be wrapped on as a bandage, but around the perineum I prefer it laced on, thereby preventing the urine penetrating the edges if the bandage were used.

The splint was bandaged snugly to the leg and to two-thirds of the length of the thigh. Adhesive straps held the tin bands firmly to the trunk. The tin bands were so riveted to the iron that they could turn a bit. This allowed the adhesive strips to be applied to different skin surfaces at each dressing. The rest of the body was exposed to inspection and proper care.

Extension can be applied from the cross arm beyond the foot. This projecting part can also be rested on a small sand bag, thus relieving strain. The patient can be turned and the side rested on a bolster for change of position.

I have used this splint in two cases. Both experienced immediate comfort gratifying to patient and doctor. The first patient had had an osteomyelitis of the other leg. Her only complaint now is that this leg

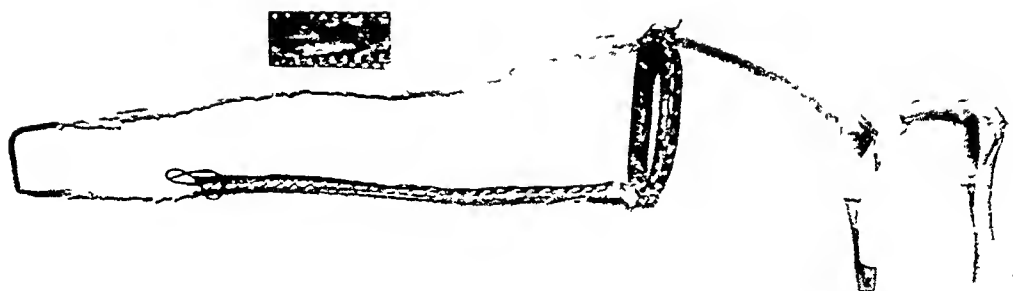


FIG. 1.—Splint for cases of fracture of the neck of the femur. Waterproof artificial leather eye-letted (small section separate) covers the perineal ring and as much of the rest of the splint as desired.

SPLINT FOR FRACTURES OF THE NECK OF THE FEMUR

is not as good as the leg that had been broken. She had no complications. I show the X-ray plates of the second patient taken at the time of and eight weeks after the fracture. She has firm union, good joint movement, and while the time is yet too short, she should ultimately walk without support. In this patient there had been poor circulation prior to the accident. In fact, vertigo and weakness were prime factors in her accident. She suffered during her illness not from the fracture, but from œdema and stasis in both her feet. It gave, however, no great trouble. The general health was excellently maintained.

In both of these cases there was displacement of the fragments. In the second case the lower fragment projected forward so markedly as to simulate an anterior dislocation of the hip-joint. In both cases manipulation reduced the deformity. In the first case there is no deformity, in the second a hardly perceptible shortening. Both these cases have convinced me that we should not let our fears of doing injury dissuade us too much against intelligent manipulation under anæsthesia relaxation to correct the deformity at the time of injury.

ANHYDROUS COCAINE SPINAL ANÆSTHESIA*

BY JAMES RALSTON WELLS, M D
OF PHILADELPHIA, PA

BEFORE arriving at the exact title matter of this address, let us briefly review the subject of spinal anæsthesia or analgesia (because by this means of insensibilisation the protopathic sense is subdued before the epicritic, motor, or muscular senses) In 1885, Corning, of New York, attempted the first work on the spine to produce analgesia For this he used cocaine, but did not enter the spinal theca Quincke, in 1891, introduced the lumbar puncture, but it remained for Bier,¹ in 1898, to first perform a lumbar puncture for analgesic purposes Using cocaine as his agent, himself, his assistant, and six patients as subjects, were given the initial doses His results were most discouraging, all eight subjects had severe vertigo, vomiting, and headache In 1900, Tuffier,² of Paris, reported 80 cases, cocaine used, with good results and no deaths Reclus³ reports six deaths with cocaine In 1902, Perkins⁴ reports 2345 cases and 16 deaths In 1891, Giesel isolated tropococaine, Chadbourne named it a year later, then followed stovaine (Tourneau in 1904), and novocaine (Einhorn, 1904)

To continue, in 1905, Morton⁵ reported 2066 cases, 1427 of which with cocaine, the balance with tropococaine, no deaths Bier⁶ reported 305 cases with no serious results In 1908, Sonnenburg, Kunnell, and Allesardri collectively, have reports numbering 3235 cases with 3 deaths, while Bruning reports 3 deaths in 450 cases Barker,⁷ in 1908, in his first series of about 300 cases reports 6 per cent mortality, while in a subsequent series of 475 cases no deaths occurred Strauss,⁸ in 1909, collects a series of 22,717 with 7 deaths, Houghton 735 cases, no deaths, McGavin, 844 cases, no deaths, therefore, in this series from 1908 to 1914 of about 28,746 cases, the mortality is not over 1 in 1200 The Ryall⁹ statistics (1911) report a general mortality of 1 in 13,000 Babcock¹⁰ (1915) reports 1295 cases, no deaths Yount,¹¹ in 1917, reports 5160 cases, 1 death, Jonnesco, 10,000, no deaths (1915-1917 mortality 1 in 16,000)

With this array of figures, some of which may have been reduplicated, and many more omitted or not recorded, we may draw the conclusion that spinal anæsthesia is gaining in popularity and losing in mortality Is it a sky-rocket bursting brilliant, then falling, as it was spoken of by Wm M Perkins in 1902, or is it reaching its logical, useful level among our anæsthetics?

That it has a definite place in surgery is becoming a fact More exact knowledge of the general underlying principles involved will lead to results more near perfection The death-rate varies with the different

* Read before the Philadelphia Academy of Surgery, January 5, 1920

reports and at best no exact rate can be ascertained, because different surgeons in attributing death to anæsthetics include deaths in cases of advanced toxæmia and poor surgical risks, while others exclude them. The mortality may also be based on a series of one year's cases and referring to one drug only, while others cover a number of years, including from the earliest use of cocaine in its impure form, up to the most advanced technic and perfect isolation of the pure drug used. So one may report three deaths in three cases, while another may report thousands and no deaths, and all gradations between. Another point. While immediate operative mortality of spinal anæsthesia is higher than that of ether, the additional mortality from post-operative complications following ether narcosis would probably about balance them¹⁴

Spinal analgesia may be condemned as dangerous, and it is not without danger, but in any case where a general anæsthesia is contraindicated, the use of any anæsthetic is a risk, as, for instance, in advanced peritonitis or strangulated hernia, in advanced cardiac or renal disease, in which many surgeons will advocate spinal analgesia. Why? Because they think there is less danger of death immediate or post-operative. Is this a fair trial for spinal anæsthesia? If it is *less* dangerous in these cases, why would it be more dangerous in the general run of surgical conditions where the chronic heart, kidney, or advanced toxæmia is not present?¹² There is no post-operative mortality nor delayed toxic state due to spinal anæsthesia (Sanders¹³)

We all have seen the picture of an acute abdomen, the set, anxious face of severe suffering, the distended, rigid abdomen, the rapid, bounding pulse, increased respiratory rate, and a pyrexia of possibly alarming proportions, to those who have never seen a case of this kind under spinal analgesia, to see the expression of pain practically gone, the rigid muscles relaxed, the general attitude of tranquillity supervene, is a revelation and one never to be forgotten, one that makes us think, whether it is wise to always subject such a patient to ether anæsthesia with its accompanying phenomena, the initial twenty to thirty minute struggle accentuating all conditions that we wish to avoid, *i.e.*, the congested flushed face, rapid respirations, hot moist skin, coughing and outpouring of mucus, a picture of stimulation and irritation.

In spinal analgesia we have a corresponding fall in diastolic and systolic pressure due to more or less paralysis of (1) The bulbar centres (2) Efferent vasomotor fibres which run in the lateral columns of the cord (3) The vasomotor fibres which pass out with the anterior roots of the cord from the fifth dorsal to third lumbar segments¹⁵ Slow, shallow respirations, *reduced* pulse rate, thus a slower working heart against less resistance, skin pale, little or no moisture, muscles perfectly relaxed, in short, a picture of rest, corresponding to sleep. These phenomena reach their height in from ten to thirty minutes, depending on the agent, amount, and strength used, and then gradually return to normal, mayhap

before the operation is completed, and almost always before the protopathic sense returns

After our initial stage of *stimulation* of ether anæsthesia, we *must* have a stage of more or less exhaustion. The patient no longer responds to ether stimula and we have the picture of a physically tired being, a drenched skin, lowered temperature, and we know in a short time the exhaustive vomiting will ensue which loses fluid, uses energy, adds to pain, and may possibly derange the operation in whole or in part

All centripetal nerve impulses from the operative site being blocked in spinal analgesia at the posterior nerve roots, lessens that shock caused by trauma to viscera or raw tissues, that shock that is not controlled in general anæsthesia, also trauma *per se* is lessened due to the extreme flaccidity of the muscles, and in abdominal operations, in addition, the loss of the tendency of the intestines to protrude into the wound. Our patient is normal, additional shock is blocked, and the original shock is not added to, at least, and if a preliminary hypodermic of morphine or scopolamine, or both, had been given, we have a partial blocking of psychic phenomena. Rarely is there post-operative vomiting and a small proportion complain of headache for a day or so

We may sum up the advantages (1) Perfect analgesia (2) Perfect muscular relaxation (3) Absence of post-operative shock (4) Absence of post-operative gastric disturbance (5) Absence of post-operative motor restlessness, so often difficult to control in ether narcosis (6) Retention of consciousness, thus allowing of deciding a point, as, for example, removal of two ovaries instead of one, as intended, also allowing of drug administration, coffee, etc., by mouth (7) Immediate resumption of gastrointestinal activity if operative conditions permit

Added to these. The extreme ease of retraction of muscles. The loss of intestinal tendency to crowd the operative field. The relief in spastic or paralytic ileus, at times removing the operative necessity entirely (Babcock reports several cases of this kind). The saving of one pair of hands for other purposes in the operating room. The small space necessary for the agent and paraphernalia, and the relative cheapness as compared to ether, etc

In enumerating the disadvantages (1) The retention of consciousness may also be classed here, for example, in a highly neurotic individual (2) Manipulation of the stomach and intestines. This at times gives rise to a "sinking" sensation, which, in turn, causes untoward psychic conditions, but these are rarely dangerous to life (3) After a given amount of the analgesic agent is injected it cannot be readily controlled. Theoretically a tap in the lumbar region will drain off the cerebrospinal fluid containing the drug, and as the ependyma (choroid plexuses) of the cerebral ventricles produces the fluid rapidly, the cord and nerve roots may be washed from above down by this means¹⁶ (4) Ether or one of the general anæsthetics can be obtained in almost any place, and its admin-

istration in the majority of cases is not difficult, on the other hand, a spinal analgesic agent is neither obtainable in all places nor is its administration so simple (5) Failure of analgesia is variously reported as from 4 per cent to 9 per cent, due in most part probably to non-entrance, wholly or in part, into the subarachnoid space, it may also be due in part to an inert agent This per cent includes complete or partial failures, unilateral and delayed analgesia

The indications and contraindications vary with different surgeons, their drug agent, technic, and experience We may safely say the following lists agree with the majority of those who have had a sufficient number of cases to be capable of judging

Spinal analgesia is indicated in (1) Cardiac conditions, alone or plus broken compensation (2) Renal conditions, especially in the presence of impending uræmia (3) Pulmonary conditions other than (*a*) acute febrile tuberculosis, (*b*) large pulmonary effusions, (*c*) *large* intra-thoracic growths (4) Inguinal, femoral, and ventral hernias (5) Shock, if blood-pressure is not too low or falling, especially in railroad accidents to legs or pelvis, and severe burns or scalds (6) Acute abdominal conditions, including appendicitis with or without peritonitis, peritonitis, intestinal obstruction, and paralytic obstruction (7) Reductions of dislocations (8) Operations on anal region, urethra, bladder, prostate, uterus, and appendages (9) Plethora, atheroma, and chronic alcoholics (10) Lastly, the large class we all know, the stat case who has developed an acute operative condition within a short time after the ingestion of a full meal

Of the contraindications, let us mention (1) Subject with lowered blood-pressure (hypotension) (2) Turbid spinal fluid (3) Diseases or tumors of the brain, cord, and meninges (4) Recent syphilis (5) Intra-thoracic conditions, as (*a*) very large effusions, (*b*) *large* growths, especially mediastinal (6) Advanced toxic or moribund cases of peritonitis (7) Acute febrile infections, especially acute pulmonary tuberculosis (8) General sepsis or suppuration near the point of spinal puncture (9) Finally, where patient cannot stay in bed for twenty-four hours after operation

If some one drug and some one technic that answered all requirements were found, the ideal state would be reached The ideal is always our aim, in everything progress is made because the ideal has not been reached, thus our research, our experiments, and our discoveries Cocaine as a spinal analgesic was found in the broad, main principles, good, but dangerous (1898) Then followed tropococaine, stovaine, novocaine, alypin, syncaïne, each possessing qualities of perfection, each having the broad good principle of analgesia, but each falling short of the perfect, and so we bear them in mind, but still hunt for the more nearly perfect agent Up until this time we have been rather limited in the operative field, few surgeons operating above the costal border, rarely above the nipple line Various agents in combination have been tried Barker advocates a specific gravity heavier than spinal fluid, Babcock especially

a lighter, although he uses a heavier also Jonnesco combines strychnine, others use chloretone as a solvent, still others, sterile salt solution, and so on

As to technic, many use Quincke's point, others Tuffier's point, still others, notably Babcock and Jonnesco, have injected opposite the segment supplying the part to be operated The position of the patient is taken into account, heavier or lighter fluid in the spinal canal may rise or fall, as the case may be, when the patient sits up, lies on one side, prone or in Trendelenburg position And other variations can be noted in looking over the various methods of administration that have been advocated The method of having a drug pure, uncombined, and dry, being dissolved in the subject's own spinal fluid immediately before injection, has been mentioned in reports, but has never found the general favor as have the prepared sterile ampules of fluid

To Dr Paul Delmas, of the University of Montpellier, France, Chirurgien Consultant Régional of the XVI region, a surgeon active in front war surgery, as well as base hospital work, my friend and teacher, I owe the majority of the following matter in this paper I will, with his permission, quote liberally from his manuscript copy of a report which he gave me in the spring of 1919

Quoting "The greater part of spinal anæsthesia has been confined to a variable upper limit of actual analgesia not ascending perfectly much above the umbilicus To the work of Lefilliatre by the demonstration of many thousands of cases, we owe this sphere broadened to include the whole body, with a certainty and without risk, by the simple preliminary subtraction of spinal fluid The height of the analgesia is the function of the fluid withdrawn The diffusion of the active principle which has produced it, mounts higher in proportion as the resistance is less, which is opposed to its penetration by the volume of the superimposed liquid As this pressure to be overcome increased with the elevation, any dose whatever obtained a duration so much the more brief with the higher the elevation, or inversely to the anæsthenization of the higher parts, requiring progressively increasing doses"

During the progress of the war, Doctor Delmas employed the procedure of Lefilliatre Added experience and study led him to modify the technic so as to attain unity of dose with unity of time, whatever might be the height desired

Instrumentation—Spinal puncture needle (trocar and cannula), all glass syringe, Luer type, 20 cc Needle preferably of platinum-iridium, 7 cm long, 1.4 mm diameter, model of Bruneau, the point brought to an abrupt bevel

Anæsthetic Agent—"Purified hydrochlorate of cocaine," prepared by Templier, Paris, or by an anhydrous process explained later in this paper "This cocaine used to the exclusion of all other substitutes which are less active and less diffusible, hence necessitating stronger doses" Co-

came crystallized, dry, put up in sterile ampules, dissolved at the moment of use in the cerebrospinal fluid of the patient "Solutions prepared in advance, by reason of molecular action observed, renders them promptly unreliable and injurious, the same is applicable to sterilization, heat altering the physiologic activity of the product "

"The lumbar puncture is performed at a level just above the sacrum " (between the fourth and fifth lumbar vertebræ Tuffier's point) The syringe takes in 20-25 c c of fluid, is detached from the needle (trocar being inserted), and the first 20 c c thrown away, to have access with a certainty to the higher spaces The ampule of cocaine, dry crystals to the dose desired (01-05 gm), is opened, the remaining spinal fluid, 3-5 c c , is put into the ampule and the whole gently agitated The barrel of the syringe is charged with the freshly prepared cocaine solution, readjusted to the needle, 20 c c of new spinal fluid is drawn into the syringe, the whole is thrown forcibly back into the subarachnoid space The force used is in proportion to the height desired (the higher the more force necessary) "This fluid column of analgesic liquid immediately diffuses in a homogeneous fashion into the remaining spinal fluid which impregnates to the same degree all the posterior roots " The reason of this is that "to the preliminary hypotension created by removing 20 c c of spinal fluid, there is added the force of penetration of a relatively large charged mass (over one-third of the remainder) " All parts, needle-syringe joint, barrel, and plunger of syringe must fit tight, allowing of no leakage whatsoever

The analgesia of the entire body is instantaneous if maximum force is used "The other manifestations of sensibility, contact, and temperature, are not necessarily disturbed, conduction of pain alone is interrupted totally independent of the elevation Duration of 01 gm equals a minimum of fifteen minutes, this is often exceeded " The quality of analgesia is not altered by size of dose of agent, 01 gm giving as perfect a result for fifteen minutes as 04 gm for one to one and a half hours "The action seems to be confined practically to the posterior ganglions alone, voluntary or reflex action is apparently undiminished Ideation, circulation, and respiration are little, if any, slower than normal " Blood-pressure is possibly lowered, but not to a dangerous degree No exact data as to this important condition have been made

Doctor Delmas reports 431 cases by this agent, the results being No failures, no mortality, immediate or following, due to analgesia, not even any alarm on the table After effects, if any, have been very slight and transient Doctor Delmas ends his report with "So the procedure is to be employed above all in cases which contraindicate a general anæsthesia, such as those suffering from shock, hemorrhagic, pulmonary, cardiac, albuminuric, diabetic conditions, and in general, all those who are doubtful risks "

* The amount of spinal fluid in a normal individual is about 70 c c Later findings place the amount from 125 c c to 150 c c Dercum, F X, Dec. 8, 1919

"It is contraindicated in local sepsis at point of puncture, general cerebral tumors, fragile vasculatory systems in which one fears an intra-cephalic lesion"

I might add the sterilization of the puncture site is tincture of iodine one-half strength, two coats Area includes from posterior inferior spine to posterior inferior spine, and from below the upper level of the sacrum to the first lumbar vertebra

The method of purifying the cocaine has been carried out by Professor Gardin, of the University of Montpellier, together with Doctor Delmas It consists of dissolving a given quantity of commercial hydrochlorate of cocaine in a given amount of absolute alcohol, recrystallizing by the addition of absolute water-free ether (sulphuric), decanting off the liquid, drying the crystals in a vacuum or a sulphuric chamber Collecting, weighing, and putting crystals in ampules under sterile conditions Glass of ampules should be colored preferably brown, size approximately 5 c c

In conclusion, my own experience with this anhydrous preparation of cocaine has been one bearing out Doctor Delmas in practically all particulars The operative range of this analgesia includes operations on the forearm, glands of the neck, wounds of the scalp, and even a trephine For resection of a rib in empyema or war wounds, it is apparently ideal Post-operative headache is sometimes complained of, but not for long nor is it excessive in severity There is no tingling or burning of the feet or legs as at times is met with in, for example, novocaine or syncaïne, which agents I have observed used in several of the French clinics

The posture when injection is made can be either sitting or lying, apparently there is no difference in result, the sitting posture is the more easy of injection The analgesia is practically instantaneous The toxicity has not been, to my knowledge, up to this time, worked out for this preparation of cocaine, but in a later report I hope to be able to present this phase

A spinal analgesic is not an anæsthetic to abolish ether or even to supplant it, but is a very valuable aid to our anæsthetic series, and one, when ether is contraindicated, which may lessen our general surgical mortality

I should like to add that to import this preparation of cocaine from France has been thus far impossible, but through the kindness and co-operation of Dr George W Raiziss it has been produced in the Dermatological Research Laboratory, Philadelphia, according to the original French formula

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held January 5, 1920

The President, DR GEORGE G ROSS, in the Chair

THREE-WEEKS-OLD EXTRA-UTERINE EMBRYO

DR ASTLEY P C ASHHURST reported the case of a woman, aged twenty-six years, who was admitted to the Episcopal Hospital during the night of August 21, 1919, complaining of pain in the lower right quadrant of the abdomen. Her last menses, which began August 5, were normal. Eight days before admission (that is, August 13) she began to bleed again, and to suffer some abdominal pain. On admission she was thought by the receiving ward interne to have salpingitis, and she was sent to the ward over night. In the morning she appeared slightly anæmic, and a diagnosis of ruptured extra-uterine pregnancy (right) was made. The pain persisted, and there was a very tender mass in the region of the right tube.

On opening the abdomen the presence of free fresh blood confirmed the diagnosis, the right tube was distended and tense with blood, and bleeding from the fimbriated extremity continued. The tube and ovary (and, incidentally, the appendix) were removed, the blood evacuated, and the abdomen closed. Recovery was uneventful.

Section of the tube discloses an embryo (Fig 1), apparently about three weeks only in age, lying lengthwise in the tube, in the midst of blood clot. The membranes were intact. Evidently tubal abortion was impending at the time of operation.

DR W H F ADDISON, Professor of Histology and Embryology in the University of Pennsylvania, very kindly examined the specimen under the microscope, and reported its length as 10 mm. The cephalic extremity was somewhat crushed, but the limb buds could be detected, they showed no indication of any digitations, nor even club-shaped expansion of their ends. From these data he estimated its age at about thirty days.

SAC OF INDIRECT INGUINAL HERNIA WITH COMPLETE OBLITERATION AT ONE POINT

DOCTOR ASHHURST also reported the case of a man, aged twenty-six years, who wore a truss for about eighteen months, when a small boy, for right inguinal hernia. Since childhood the hernia had not been down.



FIG 1 —Very early extra-uterine pregnancy (three weeks) Embryo living in a mass of blood clots in the tube—actual size

ABNORMAL DRAINAGE FOLLOWING CHOLECYSTOSTOMY

until it appeared as an incomplete indirect right inguinal hernia, after a lifting strain a few days before operation, which was done January 2, 1920, at the Episcopal Hospital. The sac extended below the level of the external ring, and its fundus was distinct from the tunica vaginalis testis. When the sac was opened near its fundus, it was found obliterated about 4 cm. distal to the internal ring. The proximal portion of the sac, continuous with the peritoneal cavity, was then opened, and both portions of the bilocular sac excised, and the inguinal canal was repaired in the usual way (after incidental appendectomy through a McBurney incision).

Doctor Ashhurst remarked that one knows how frequent it is to meet with partial occlusions of such hernial sacs, at one or more levels, and the occurrence of hydrocele of the cord proves that complete obliteration may occur. But the question is, does wearing a truss for eighteen months, or even for eighteen years, produce such an obliteration? It seems very unlikely that it ever does, certainly nothing he had ever encountered in an operation for inguinal hernia indicates that it does, and even granting that this case is an instance of the occurrence, the fact remains that the obliteration occurred not *at the internal ring*, where it might prevent recurrence of the hernia, but in the course of the sac as it passed through the canal, and that the hernia did recur in the proximal portion of the sac.

ABNORMAL DRAINAGE FOLLOWING CHOLECYSTOSTOMY

DR EDWARD B. HODGE reported the case of a woman, a patient of Dr. A. B. Gill, who was admitted to the Presbyterian Hospital July 12, 1916, with history of removal by Doctor Gill of a subacute appendix four years before. For the past ten months there had been attacks of pain in the epigastrium, radiating into the back and right shoulder at times, nausea, vomiting, and epigastric tenderness. When seen a week before, there was slight jaundice. No fever in this or previous attacks. A diagnosis of cholecystitis had been made and operation decided on when jaundice subsided. Although this was still present, pain was so severe as to demand relief.

Under gas-ether an enlarged, rather thick-walled gall-bladder was exposed. It was adherent to the omentum. Stones were felt in the gall-bladder but not in the common duct. The foramen of Winslow was open. The gland at the junction of the cystic and common ducts was enlarged as also the pancreas. The stomach and duodenum were normal. Difficulty in relaxing the patient prevented good exposure, so drainage rather than removal of the gall-bladder was done. There were many dark green stones and the mucous membrane was moderately inflamed, but not of the "strawberry" type. A tube was placed in the gall-bladder and a cigarette drain to the kidney pouch.

For forty-eight hours she did well. In the first twenty-four hours there was drainage of more than a pint of bloody mucus and bile, later

becoming green For the first fifteen hours of the second twenty-four there was no drainage On the evening of this day, the fourteenth, drainage became free again, and by evening of the fifteenth amounted to 70 ounces (2100 c c) of turbid fluid with some flakes in it Temperature was 100°, abdomen soft, passing flatus, stomach a little unsettled, and pulse weaker and 120 She was beginning to feel very weak and prostrated The weather was extremely hot

From this evening to the next morning the amount of drainage was 1050 c c of the same character Her condition was now alarming with small weak pulse, extremities cold, clammy and bluish, face yellowish, but lips a good color, breath not bad, and no acetone in urine which had become very scant in the last twenty-four hours Stimulation was increased and saline given under skin in addition to the glucose-sodium bicarbonate solution that had been used by rectum At this time Doctor Jopson saw her in consultation The question of attempting to check the excessive drainage from the gall-bladder was discussed, since her condition seemed to be largely due to great loss of fluid by this channel A clamp was placed on the tube and from that time no fluid came from or around the tube

By the next morning the patient's condition was decidedly improved, she had had a restful night and felt better She had passed only 6 ounces of urine in the last twenty-four hours, but this was entirely negative The tube was removed four days later and replaced by a gauze strip There was thereafter no leakage She was discharged from hospital two weeks from operation and has remained in excellent health since

Colon bacillus was cultured from the gall-bladder at operation The laboratory report on the yellowish, turbid, flaky fluid at the time of the greatest amount of drainage showed unexpected findings Tests for bile acids and bile were negative The fluid did not digest egg albumin or starch and therefore contained no pancreatic ferment Quantity not sufficient for lipose test

It is readily seen that the unusual features in this case are the amount and the source of the drainage The amount of discharge, if from the liver, far exceeded anything he had found recorded in the literature or in the experience of those with whom he had discussed it The normal daily production of bile is usually given as from 700-900 c c In this case there was once 2100 c c and again 1020 c c for some fifteen hours

In the absence of positive findings for bile and bile acids, we are led to seek other possible sources There was no evidence at operation of communication between gall-bladder and stomach, duodenum or colon Nor was there any reason for post-operative development of such communication Back flow from the duodenum through a relaxation of the common duct sphincter also seemed ruled out by the laboratory findings Of one thing we can be sure—the drainage came through a tube sutured into the gall-bladder In the reporter's opinion the drainage had its

ULCERATIVE CYSTITIS

origin in the liver, even though for some reason the ordinary tests for bile were not positive

ANHYDROUS COCAINE SPINAL ANÆSTHESIA

DR JAMES RALSTON WELLS read a paper with the above title, for which see page 504

ULCERATIVE CYSTITIS

DR FLOYD E KEENE read a paper entitled "Circumscribed Pan-mural Ulcerative Cystitis," for which see page 479

DR JOHN G CLARK paid a tribute to Dr Guy Hunner for having discovered and brought this unique pathologic entity to our knowledge. As the report of these cases from the Gynæcological Department of the University Hospital will show, they have all been of chronic standing and the patients have suffered in many instances so excessively that they have become chronic invalids, the dysuria and frequency of urination being so great as practically to confine them to their homes. All surgeons in years past have persistently treated cases of this type under the diagnosis of chronic cystitis, and yet neither the cystoscopic picture nor the urinalysis bore out this diagnosis. The case that brought this type of pathology to his cognizance was the first one to which Doctor Keene alluded, of a woman who had been under observation for fifteen years for an extensive cystitis following an abdominal operation. Gradually all of the characteristic clinical findings of cystitis disappeared but the symptoms persisted and even grew worse. After several ineffectual operations of various types and the employment of every manner of treatment the patient fell into Doctor Hunner's hands, who promptly made a diagnosis of solitary ulcer, and, after she had undergone the operation which he has devised for this condition, she regained her health completely.

These cases in their variation between acute exacerbations and temporary quiescence are suggestive of the manifestations of a duodenal ulcer. Also, the symptoms are out of all proportion to the diminutive lesion which one discovers on cystoscopic examination. The lesion, therefore, is an extremely small one, but the symptoms are decidedly major in severity. When one views these small ulcers and contemplates the major operation necessary to relieve the patient the therapeutic procedure unquestionably appears to be out of proportion to the existing pathology. Nevertheless, as the results have demonstrated, there is no series of patients more grateful for their relief than these, and count the operation of small significance when they have experienced complete relief. It is to be hoped that the time will come when some other form of treatment may be instituted which may obviate so extensive an operation. Nevertheless, Hunner has given these cases the most painstaking and skilful attention, and finally through failure of local treatment to achieve favorable results, he was compelled to resort to operation. In view of

the fact that Hunner has so well defined and described this condition, there need be no great difficulty in naming the condition. We have chosen, therefore, to designate this as the Hunner Ulcer, for we feel that through his careful work he deserves this identification.

DR ALEXANDER RANDALL said that since his attention had been drawn by Doctor Keene to this type of bladder ulcer he had been looking for it in the male, but had not thus far met with it. He had asked Doctor Keene as to the possibility of the condition being tuberculosis. The ulceration of the bladder, the sterile urine cultures, and the chronicity highly suggest tuberculous origin. He replies that in repeated examinations cultures in guinea pigs have been negative as well as studies of section of excised tissue. He cannot, however, help feeling that search should be continued along this line, because as pointed out by Pelouse there has been observed another unusual form of tuberculosis in this region. Surgeons are still very much in ignorance of the actual pathology and physiology of the bladder itself, especially as regards infections.

MALIGNANT DISEASE OF THE LUNGS

DR GEORGE E PFAHLER read a paper with the above title, for which see page 472. The paper was illustrated by lantern slides.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting held January 14, 1920

The President, DR WILLIAM A DOWNES, in the Chair

TUBERCULOSIS OF THE CHEST WALL

DR WALTON MARTIN presented a man twenty-four years of age who was admitted to St Luke's Hospital in January, 1917. At that time he was a well-nourished young man with a discharging sinus in the mid-axillary line on a level with the eighth rib and a soft fluctuating tumor over the fifth rib. He was operated on by Doctor Derby. The sinus was dissected out and portions of the eighth and ninth ribs removed. The wound was left open and irrigated with Dakin solution and two weeks later an attempt made to close it by secondary suture. The wound, however, never healed entirely, and the patient left the hospital with two sinuses, one discharging anteriorly and the other posteriorly, and was running a little temperature.

On May 17th he returned to Doctor Martin's service still with his discharging sinuses and obviously not in as good condition as he had been, having an afternoon temperature and having lost weight. An extensive operation was performed, an "H" shaped incision being made, the two long arms of the "H" passing through the sinuses and the horizontal portion passing between them. The flaps were dissected back and the fifth to the tenth ribs resected with the overlying parietal pleura.

Pathological Examination—Extensive tuberculosis of the ribs removed and of the pleura. The young man improved for a while. The extensive wound healed except for two fistules, one anteriorly and one posteriorly. From time to time he ran an afternoon temperature.

X-ray examination showed much thickening of the pleura and poor expansion of the lung. It was evident that there was a tuberculous process still present which had not been removed, even by the extensive operation.

On July 5th, portions of the sixth, fifth, and fourth ribs were removed well back to the spine. The wall of the chest and the parietal pleura forming the roof of the cavity were removed. This cavity, about the size of a fist, was filled with pus, the lung was collapsed and pushed upward and backward. A strip of the visceral pleura was resected in an effort to allow the lung to expand.

On October 16, 1917, a sixth operation was performed, removing portions of the second, third, fourth, and fifth ribs as far forward as the

costal cartilages This again exposed a cavity in the pleura containing pus, but the incision of the ribs and the anterior part of the chest wall merely obliterated this cavity From this time on the boy improved, and the wound healed by primary union except for one granulating area in the region of the second rib, which led to a sinus extending upward to a small cavity apparently near the apex of the lung He was kept under observation, under as good hygienic conditions as possible, and the sinus cauterized with pure carbolic from time to time He gradually gained weight and strength, the sinus closed last June, and he is now well and able to earn his living

Doctor Martin said that he had presented the patient as he showed a favorable outcome from apparently a very hopeless condition of extensive tuberculosis of the ribs, which had extended to the neighboring pleural cavity and had become secondarily infected, causing a chronic empyema Curiously enough, there was no evidence at any time of a second tuberculous focus elsewhere in the body

TREATMENT OF MYXŒDEMA BY TRANSPLANTING PORTIONS OF A HYPERPLASTIC THYROID GLAND

DR CHARLES N DOWD presented a woman, aged forty-seven years, who was admitted to the Roosevelt Hospital May 16, 1919, on account of myxœdema Four years before she had been a telephone switchboard operator and was then able to do the rapid work incident to that occupation Her mental processes and her speech had gradually become very slow She had frequent dizzy spells, dyspnoea on slight exertion, puffiness below the eyes, and a dull expression in face Her skin was thick and dry Her hair was falling out rapidly and what remained of it was very dry Her finger nails were also thickened The thyroid was not palpable

Another patient was in the ward who had hyperthyroidism This presented a particularly good opportunity for transference of thyroid transplants from a patient who had too much thyroid activity to one who had too little, and accordingly this was done on May 24

The gland which was removed was manifestly hyperplastic and made an excellent specimen for grafting During operation, an opening was made in the cancellous tissue of the head of the left tibia about one-half an inch wide and one-half an inch deep The oozing was carefully stopped in this pocket by gauze pressure The piece of thyroid was cut to fit it and was introduced so as to apparently fill it completely The periosteum was then sewed over it and the skin sewed over the periosteum An incision had also been made in the lower part of the left rectus muscle through the rectus sheath into the peritoneal tissue Seven or eight pieces of the excised thyroid gland, about one-eighth of an inch by one-quarter of an inch in their diameters, were inserted into this peritoneal tissue and the rectus sheath reunited with catgut in front of them Six or eight other similar pieces of thyroid tissue were

TREATMENT OF MYXŒDEMA

then implanted in the abdominal wall in front of the rectus, and the skin closed with silk suture. About fifteen small punctures were made in other parts of the abdominal wall and little pieces of thyroid tissue were inserted in them and the punctures closed with silk stitches.

Recall Notes—July 13, 1919 Patient feels very much better. More energetic and active. Speech much improved. Dizzy spells on sudden motion returned about two weeks ago. Has gained 12 pounds. Good appetite. Bowels good. No thyroid extract since operation.

September 28, 1919 Gained 30 pounds. Eyesight greatly improved. Hair growing rapidly on scalp. Speech improved. Appetite fine. Skin still dry. General health excellent.

October 5, 1919 Speech better. Voice lower. Skin more moist. Hair returning. Skin not so thick.

November 9, 1919 Feels very much improved. Good appetite and digestion. Bowels fair. Weight about the same. Dizziness and speech better. Taking tonic for about two weeks, no thyroid. Desiccated thyroid prescribed, gr $\frac{1}{4}$ t i d.

January 10, 1920 Improvement continues. Her mental activity has returned. She has good strength and takes an active and intelligent interest in various affairs and in domestic work. Her skin has softened and the dryness has disappeared. The thickness below the eyes has disappeared. Her hair has grown thicker and less dry. The symptoms of myxœdema have almost disappeared.

DR HOWARD LILIENTHAL asked if he understood correctly that the patient with myxœdema was taking thyroid extract at the present time. If so, why? Was it because she was backsliding before the administration of the thyroid was begun? If not, why was she taking it? He suggested that as so many thyroid transplants had been put in, one be removed to see what had become of it. Doctor Lilienthal stated that he had made a transplant from an animal and it was absorbed. In skin transplants it had been found to be an advantage to get as nearly the same blood chemistry in the two individuals by making blood-grouping tests, and it occurred to him that this was a good place to bring out the same point in connection with making thyroid transplants from one patient to another. Whether transplants were made of skin, thyroid, or any other organ it was important to see that the blood chemistry of the two individuals was not incompatible. In making such transplants there were a good many other factors to be taken into account both in transplanting from one human being to another and in making autogenous transplants. Carrel had made a study of transplants from one species to another and found that there was always absorption of the tissue by the host.

DR WALTON MARTIN said that while he was in Cleveland several months ago he had seen in Professor Marine's laboratory a number of rabbits in which the thyroid had been transplanted. The autogenous grafts grew well, but the grafts from one rabbit to another grew for a time and then slowly disappeared. Doctor Martin stated that Prof. Marine was attempting to carry out Doctor Lilienthal's idea of making some sort of blood grouping.

DR JOHN DOUGLAS said that what he wished to say was related to skin grafts rather than to thyroid transplants, though it might have a bearing on the latter in relation to autolysis of transplanted tissue. Within the last six months, he said, he had made a number of skin grafts on a patient and found that it was necessary to make still further grafts. He had the patient's blood tested out with that of her brother's and found the grouping exactly the same. He then used skin grafts from the brother and while the grafting was not followed by infection and the grafts did well for about ten days and appeared to take perfectly, by the end of three weeks they had gradually autolyzed, and this without any supuration. He subsequently made grafts from the patient's own skin and they all took and healed perfectly.

DOCTOR DOWD, in closing the discussion, said as to the thyroid transplants, he had not at first taken the matter very seriously and had not believed that they alone would be able to permanently and sufficiently carry on the thyroid function. The occurrence of two patients side by side, one with hyperthyroidism and the other with thyroid deficiency, gave a particularly good opportunity for trying the transplant. The subject had been well worked out and was recorded in the literature. The reports indicated that a certain degree of improvement could be expected and that sometimes it had lasted for a very long time and that excised transplants had shown active blood supply. After the operation, this patient disappeared and was not seen during the summer. When she was seen in the fall her improvement was really remarkable. She had suffered no relapse, but it certainly seemed wise to give her desiccated thyroid by the mouth to insure the continuance of the improvement. The result of the operation had certainly been very satisfactory and if she should have a relapse and another hyperactive thyroid could be obtained, a repetition procedure would be justified. The question of blood grouping had been considered and he hopes to work it up at a later time.

TREATMENT OF OBLIQUE FRACTURE OF THE FEMUR BY BINDING WITH CHROMIC CATGUT

DR CHARLES N. DOWD presented a girl of five years, who had sustained a fracture of the thigh on September 29th, and had been treated by the application of a long plaster-of-Paris spica.

On October 4th, the X-ray indicated overriding and faulty position, and measurement, with plaster removed, indicated shortening of one inch. Effort was made to overcome this shortening by strong traction. Vertical suspension was then applied to the legs so as to raise the buttocks from the bed. This procedure did not meet with the ordinary success. The shortening and overlapping remained.

On October 20th she was anesthetized. Traction and manipulation were unsuccessful. The overlapping fragments were therefore exposed.

by operation The fracture was oblique, two and three-quarter inches long, just below the middle of the femur There was a very large amount of callus Apparently, the rapid formation of the callus had prevented the success of the previous traction When this callus was removed and traction applied by the aid of the Hawley table, anatomical apposition was easily obtained

It is difficult to apply Lane's plates to a small bone for an oblique fracture as long as this, but very easy to apply some form of binding, hence five wrappings of chromic gut were passed around the bone near each end of the fracture A half-hitch was taken with each wrapping and the ends were so tied as to tighten it all The resulting support was remarkably good The fragments fitted accurately into each other and after they were bound in this position the firmness of the bone was most satisfactory

A supporting spica of plaster-of-Paris was then applied from the costal border to and including the foot and the patient returned to the ward

The technic of the procedure was shown in the accompanying diagrams Doctor Dowd stated that an ordinary uterine sound could be filed into a crochet needle and bent into the desirable shape, or a "Parham Band" passer may be used The chromic gut might be passed and fastened by instruments without contact with gloves (Lane technic) if one so desires

X-ray pictures taken three days after the operation showed accurate anatomical apposition, those taken ten days after the operation showed a very slight bending of the bone, those taken after another week showed a little more bending but no shortening The chromic gut, together with the plaster-of-Paris dressing, were sufficient to hold the bone fragments until they united in satisfactory position At the present time there was good union with no shortening, but with moderate anterior bowing of the femur

The method used for this patient must have a very limited application It did not give as lasting support as metal plates did and hence was not reliable It was, however, much easier of application to long oblique fractures It avoided the late discomforts which occasionally come with metal plates and in this case, at least, it held the bone as long as was necessary

DR ROYAL WHITMAN did not approve of the method of treatment described by Doctor Dowd In his opinion, a plaster spica would not, as a rule, prevent overriding of the fragments, while perpendicular traction aside from its discomfort must lessen the blood supply and thus delay repair He thought the most satisfactory treatment for fracture of the femur in childhood was, having adjusted adhesive traction straps to the limb, to completely reduce the shortening under anæsthesia A closely fitting plaster spica was then applied, and this was

supplemented by a sufficient traction weight to prevent displacement by muscular action

DR H B DELATOUR stated that he had used catgut on the clavicle where there was an oblique fracture and overriding, and a possibility that the sharp ends of bone would puncture the skin. By wrapping the clavicle with catgut he had obtained very good results. He was not certain, however, that the results would be so satisfactory in the femur.

DR JOHN B WALKER stated that he had abandoned the treatment of fracture of the femur by suspension because he had obtained the same unsatisfactory result so often. He felt that one could not rely upon suspension.

DOCTOR DOWD, in closing the discussion, said that he was glad the question of treatment of fracture of the femur by a plaster spica had been raised. He agreed heartily with the statement that this catgut wrapping was not an efficient treatment unless the fragments were also held together by some other means. He had looked at it with suspicion when its use was being advocated. Later results had proven that the plaster spica could not be depended upon to maintain the fragments in suitable apposition. The case which he had shown had already been thus treated when it came under his care and the callus which had formed during that period probably prevented the suitable lengthening of the leg after the suspension treatment was used.

On the other hand, the treatment of fracture of the femur by suspension had proven very satisfactory for young children, but had not been efficient for children older than five or six years.

The case had been brought before the Society to illustrate the way in which the chromic gut binding had proved efficient in this particular instance. The method had a very limited application. It could not be relied upon to hold the fragments for more than ten days and should only be applied for long oblique fractures, and the fractured bone should be supported by an external appliance so as to maintain the position after the chromic gut has begun to loosen.

INJURY TO LOWER EPIPHYSIS OF THE TIBIA

(Five years after accident)

DR H BEECKMAN DELATOUR presented a boy who was admitted to St John's Hospital, Brooklyn, five years ago, and was ten years of age at that time. He had sustained an injury to his ankle. While climbing on a picket fence he had fallen, catching his foot between the pickets and twisting his ankle. He presented all the signs of a fracture of the ankle at the lower end of the tibia. Doctor Delatour presented the X-ray plate taken at that time, showing a slight degree of displacement internally at the lower end of the tibia. The ankle was put up in a plaster case and at the end of four weeks a second X-ray, which Doctor Delatour exhibited, was taken which showed that the boy left the hospital with his

INJURY TO LOWER EPIPHYSIS OF THE TIBIA

ankle in absolutely perfect condition, without any deformity. At that time all the movements at the joint were perfectly normal. The boy wore the case for a week after leaving the hospital, it was taken off at the end of the fifth week. After this the boy went along apparently in normal condition for three years, when his mother noticed that his foot was beginning to turn a little. The deformity then gradually became more marked and from that time he had had the deformity which he now presented. As could be seen the whole foot was thrown inward and there was about an inch shortening of the limb. There was the same amount of shortening if one measured the tibia itself. The boy, Doctor Delatour said, went about with perfect ease but the deformity was increasing. Another X-ray plate taken a month ago showed what had taken place. The inner one-half of the tibia had not developed while the outer one-half had developed in the normal manner, with the result that there was a turning of the foot inward and a corresponding change in the upper surface of the astragalus.

This case was interesting because the injury was not the result of a direct blow, but of twisting, and because the injury had been to the epiphysal line of the tibia. The question was what could be done to prevent further progress of the deformity. As was well known ossification was not complete until the eighteenth or nineteenth year, and in the fibula it was a little later. If there still remained a period of three or four years during which these bones might grow a much greater deformity than he now had would develop. Occasionally there were two points of ossification in the lower end of the tibia and the question had suggested itself to his mind whether the internal one alone was injured. This case was also interesting from the standpoint of prognosis. Any one who saw the boy at the time he left the hospital would have said that the result was perfect. Again it is rare that an injury to the epiphysis produces shortening, but this case shows what might happen. The boy had consulted an orthopedist, who drew a diagram of the condition showing that the boy had sustained an oblique fracture which pushed the inner one-half of the tibia upward. He stated that an osteotomy was indicated to straighten the leg.

This case might also be interesting from the medico-legal standpoint in that it might lead to a lawsuit for damages if one did not have the X-ray plate to show that the result was perfect at the time the boy left the hospital.

DR ROYAL WHITMAN said he had seen several cases of this type. In this instance, as the patient was well advanced in adolescence, the prognosis as to the final result should be good, since there was but slight varus and a full range of motion in the ankle-joint. The disproportionate length of the fibula did not as a rule interfere with function, and eventually the lateral deformity might be permanently corrected by osteotomy.

NEW YORK SURGICAL SOCIETY

APERIOSTEAL, SUBTROCHANTERIC AMPUTATION OF THE THIGH

DR HENRY H M LYLE presented a boy who, twelve years ago, had a fracture extending into his knee. The fracture resulted in an infection of the knee-joint and an osteomyelitis of his femur and tibia. In the course of these twelve years he has had ten operations in four different hospitals. Finally he was referred to Doctor Lyle's service at St. Luke's for a disarticulation at the hip.

The condition at admission was that of an active osteomyelitis of the femur, with destruction of the knee-joint and numerous discharging fistulæ of the thigh. The X-ray plate, Doctor Lyle said, showed the amount of bone involvement. It would be noted that it extended to within two inches of the trochanter.

Knowing the difficulty in getting a good working artificial leg for a disarticulation of the hip, Doctor Lyle decided to do a subtrochanteric amputation of the hip, and to try for an end-bearing stump. An external racquet incision was employed and the bone sawed through one inch below the trochanter. The flaps were left open and the wound treated by the Carrel-Dakin method and traction. Sterilization was obtained and a secondary suture of the wound performed. The patient was then placed on the stump exercises, and two weeks after the closure of the wound was fitted with a temporary bearing peg leg.

X-ray examination of the stump showed it to be perfectly smooth.

The boy was later fitted with a permanent artificial leg. He had been wearing this leg ever since the operation, more than three years ago. It could be seen how well he walked, in fact, for some time, he was a demonstrator and teacher in the use of artificial legs.

Doctor Lyle said his object in showing the case was to demonstrate the value of short bony stumps, and to show that, far from being a useless operation, the aperiosteal subtrochanteric amputation of the thigh had a definite place in surgery, as it gave a superior functional result.

Doctor Lyle said he had performed five subtrochanteric amputations—two in this country and three abroad. The other one done in this country had been shown before this society. All five had had good functional results, which went to show the incorrectness of teaching that this operation is useless unless you can save at least three inches of the bone below the trochanter.

IMMEDIATE ACTIVE MOBILIZATION OF THE WRIST-JOINT FOLLOWING EXCISION OF FRACTURED SCAPHOID

DR BURTON J LEE presented a young man, nineteen years of age, who had been in the service abroad. Doctor Niles had originally seen this case. The patient had sustained an injury to the wrist while playing football, but had lost no time from duty in consequence. However, the wrist had shown moderate disability which had been present from the receipt of

the injury up to the time when Doctor Lee first saw the case, which was five weeks ago. The joint was tender over the scaphoid region and there was slight general swelling of the whole wrist. Motions of the joint elicited slight pain which was very much increased by extreme flexion. The boy had, however, continued to play football and hockey with the wrist partially immobilized by an adhesive plaster bandage. Doctor Lee showed the X-ray plates taken by Doctor Imboden. The diagnosis lay between disease of the scaphoid (bone cyst or tuberculosis), a primary fracture of the bone or a fracture following disease of it. It was finally concluded that the diagnosis and relief of symptoms could be only made with open operation.

Operation was performed through a dorsal incision and the scaphoid removed. The bone had been fractured, the two pieces being glued together with loose cellular tissue. The wound was closed and treatment by immediate active mobilization carried out. Perfect function had not yet been fully restored, extension still showing about ten degrees of limitation while flexion was fifteen degrees less than normal. The patient was able to firmly close the fist, but the strength of the hand was still slightly impaired. A tremor, intentional or unintentional, had been present during the entire post-operative period, when the patient attempted to close his fist, but this has steadily diminished until now it is but scarcely noticeable.

Although the X-ray findings strongly suggested a bone cyst, the pathological examination made by Doctor Elser did not confirm this impression. Gross and microscopical examination of the bone showed no evidence of bone cyst or tuberculosis, but the bone presented simply a fracture with a certain amount of cellular tissue interposed.

This case illustrated very well what could be done by the Willems method of active immediate mobilization in civil joint surgery.

DR EUGENE POOL said there were two points that stood out particularly in Doctor Lee's patient, the first was the treatment of compound fractures and the second was the treatment of suppurating joints. In regard to the compound fractures, DePage was the first to emphasize strongly that in compound fractures caused by accident, such as those usually encountered in civil practice, débridement should be carried out and the wound should be closed. At first our surgeons abroad were loath to treat these cases in that way, but they soon became convinced that it was the proper method. Since his return from France, Doctor Pool said he had had four cases of compound fracture on his service at the New York Hospital. Of these two were fractures of both bones of the leg, one a fracture of the lower third of the femur and one a fracture of the humerus. All of these were treated by incision, excision of contaminated and devitalized tissue, and primary suture. In one there was a slight superficial infection which did not reach the bone nor delay repair. The others remained clean. Another point in regard to compound fractures was that after the thorough removal of devitalized and contaminated tissue through an incision of

adequate length and reduction of fragments, if one found it practically impossible for mechanical reasons or inadvisable by reason of probability of infection to do a primary suture, then it was best to leave the wound open, treating it with or without the Carrel method, according to indications. If one used the Carrel method it should be carried out in accordance with all the niceties of the technic, making of cultures, etc. In such cases it is important that the wound be sutured as soon as susceptible of closure, because any compound fracture, if left open too long, in general more than about a week, is likely to become infected and osteomyelitis to result. Probably enough had been said regarding the Carrel-Dakin treatment, but he felt that the point should be emphasized that those who did not get good results with this method probably were not using it in the right way.

In regard to the treatment of suppurating joints, he has found that in early cases with little or no bone involvement Willems method gives admirable results in the knee-joint, which lends itself as a result of its structure to evacuation of the exudate by active movements. If the infection reached the cancellous bone prolonged osteomyelitis was apt to result.

DR JOHN F. CONNORS referred to the treatment of compound fractures. He stated that during the past three months he had had four cases of compound fracture. The first case he closed and later had to reopen, the others he had treated with the Dakin-Carrel method, closing them at the end of two weeks, when the field was free from bacteria. In his opinion the later closing was the safer and better plan.

As to Willems treatment, during his last eight months in France, he saw and carried out this method wherever possible and could vouch for its efficacy. At this hospital centre many of the cases that came back splinted developed osteomyelitis, while the cases where the Willems treatment had been used were always in very much better condition.

During the past few months there had been two cases on his service treated by Dr. Moorhead, in which this method was employed with most satisfactory results, both of these cases left the hospital with perfect function. The method of mobilization which Doctor Lee applied to the wrist case, in his opinion, could be applied to almost all fractures, and he felt that the day was not far off when it would become common practice to use mobilization instead of immobilization in our treatment of fractures.

DR H. H. LYLE expressed his firm adherence to the belief that they had in the Carrel treatment the most effective method of dealing with infected wounds. He stated that he was surgeon-in-chief of one of the earliest ambulances to adopt the Carrel-Dakin treatment in its entirety—if not the second, they were the third. It was a question whether they antedated LaPanne or LaPanne antedated them, it all being a matter of a few days. He was a firm believer in the Carrel-Dakin method and practiced it rigidly for over four years.

Regarding the treatment of joints, Doctor Lyle believed that if the closed method could not be employed, the next best treatment was that developed by Willems. He had had considerable experience with the method, and could testify to its efficacy if thoroughly carried out. For some reason or other he had not been so successful in suppurative ankle-joints, and he attributed this to the fact that movement in this joint did not increase the drainage to the extent that the same procedure did in the knee-joint.

Regarding the use of Carrel-Dakin in civil life, it was Doctor Lyle's practice to treat all infected abdominal wounds, as well as broken-down pyosalpinx wounds, suppurative wounds coincident with a drained appendix, and other conditions, with Carrel-Dakin's. In over 85 per cent of the cases they had been able to perform a secondary suture. The method not only yields stronger abdominal walls, but materially shortens the patient's stay in the hospital.

Doctor LEE, in closing the discussion, stated that the ankle and the wrist lent themselves less favorably than did other joints to the Willems treatment. The results in the ankle-joint were the poorest and those in the knee-joint the best. He thought Doctor Pool and Doctor Lyle had explained the reason for this, namely, that motion gave more effective drainage in the knee than in other joints, so that the method was particularly applicable to the knee-joint.

BOOK REVIEWS

RAMBLING RECOLLECTIONS An Autobiography by A D ROCKWELL, M D
Octavo, Cloth, pp 332 Illustrated New York, Paul B Hoeber, 1920

Dr Rockwell has placed the medical profession of America under distinct obligation by this interesting volume of reminiscences which extend over a long life of eighty years, beginning in 1840, and thus including a period of wonderful changes, intense activities and unparalleled development in every phase of life, in all of which the author himself has borne no mean part. The book is all the more interesting since it records phases of personal and individual life quite different from those which have been the basis of other biographies and autobiographies which have recently been given to us.

The earlier chapters give a charming view of a childhood and early youth in a Connecticut village. The gradual transition through college days and Civil War experiences into the condition of a practitioner in a new specialty in the metropolis is detailed in a series of sketches that hold the interest of the reader to the last paragraph. It is the story of his life told in his old age by one who still retains his mental vigor and who has a story to tell that is worth telling.

The chapters which constitute Book III, which give his experiences as a trooper with Sheridan, differ from the usual tales of an army surgeon in that they are not pictures of hospital life and of surgical events and needs, difficulties and disasters, but of work done in the saddle on many bloody fields, of dangers constant and perils oft, and of fatigues and labors, of marches and counter-marches with the most energetic and daring of the cavalry leaders that the Civil War produced. Appointed surgeon of the Sixth Ohio Cavalry early in 1864, Rockwell was at once caught in the maelstrom of war and during the terrific contests that Grant waged with the Army of the Potomac during the last year of the war, he was a part of the mighty stream that flowed relentlessly on to the final plunge at Appomattox. The battles of the Wilderness, of Cold Harbor, the beleaguer of Petersburg, the reunion with the forces of Sheridan and the final dash around to the rear of Lee's Army, followed by the decisive battle of Five Forks, and the final coming out from the ranks of the enemy of the white flag of surrender, these are all graphically described by one who was a part of it all.

It was a great change from such activities, in which men were sustained by a kind of exaltation, to the position of a young doctor trying to conquer a place for himself in civil life and practice. He struggles—he marries—he adopts a specialty—he becomes an author—he succeeds. The lights and shadows of all these days form the rest of his story. Not

the least interesting chapters of this part of his book are those in which he narrates what he saw of many of the eminent men of every walk in life with whom his later work brought him in contact. We have read every word of the book, held by the charm of the story until an early hour of the morning, and lay it down thankful to the author that he has written it.

LEWIS S. PILCHER

MODERN SURGERY, GENERAL AND OPERATIVE. By J. CHALMERS DAcOSTA, M.D., Samuel D. Gross Professor of Surgery, Jefferson Medical College, Philadelphia, Pa. Eighth Edition, Revised, Enlarged and Reset. Octavo, 1697 pages. Philadelphia and London: W. B. Saunders Company, 1919.

The reviewer has before him the first edition of DaCosta's Manual of Modern Surgery, a handbook of small size, published in 1895, and which at that time served as a helpful and practical guide in preparing the writer and others for final examinations at the medical school and competitive tests in surgery for a hospital internship, it is therefore remembered with special interest and appreciation.

Through various editions this volume has had long continued and increasing popularity as a standard surgical text-book and now the eighth revised and enlarged edition appears as an octavo of 1697 pages with 1177 illustrations, truly an enormous undertaking for a single individual during a period when such efforts have been largely superseded by cooperative or joint editorship.

In this work are presented concisely the views and opinions of a veteran teacher of vast experience and sound surgical judgment and with it all he has reviewed and included the best of other modern surgical thought and opinion.

In the preface the author refers with some apology to the difficulties of revision under war conditions and yet the chapters on the newer methods of treatment in wound infections, compound fractures and injuries of the head and chest form the most noteworthy contribution to the revised edition.

The author's personal experience and opportunities for observation made it possible for him to include authoritative sections on the Carrel-Dakin technic, the most recent advances in the prevention and treatment of tetanus and gas gangrene and the now generally accepted methods in the management of fractures and osteomyelitis and kindred lesions due to the wounds of war.

The remainder of the text has been brought thoroughly up to date even though lacking in much of anything that is new as compared with the previous edition.

Opinions are expressed in several parts of the text about which there will be honest differences of thought and practice among surgeons, for

BOOK REVIEWS

instance, in his discussion of empyema thoracis, and contrary to the now generally accepted modern idea and experience, the author does not believe in "delayed" or "late" operation but continues to maintain that collections of pus in the pleural cavity should not be temporized with but that adequate provision for drainage should be provided as soon as the condition is recognized regardless of a coexisting pneumonia or the general condition of the patient

In holding this opinion he will not have the support of many surgeons who had a large experience in the management of empyema in the military hospitals including the Empyema Commission. His opinion will, however, agree with the teaching of the War Demonstration Hospital of the Rockefeller Institute and it remains for the reader to draw his own conclusions

There are forty-one well arranged chapters in all, there is a satisfactory index and the illustrations are well selected and helpful in the interpretation of the text

This work is worthy of the continued confidence of both students and practitioners of surgery and we predict for it the same demand and popularity with which former editions have been received

WALTER A. SHERWOOD

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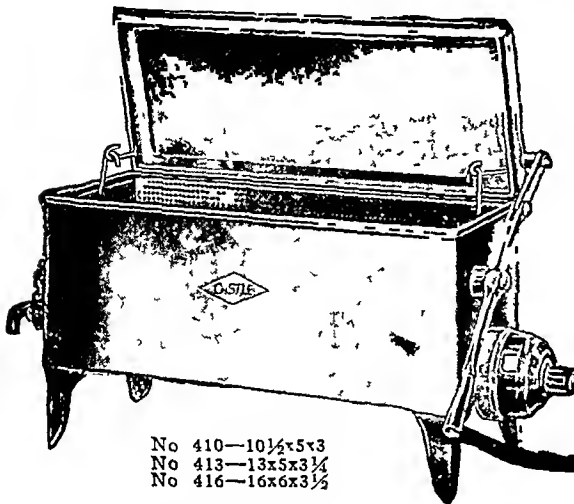
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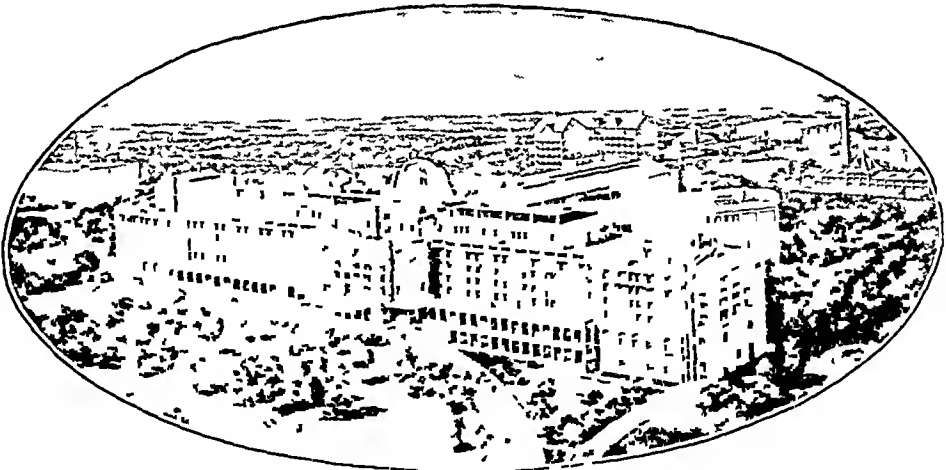


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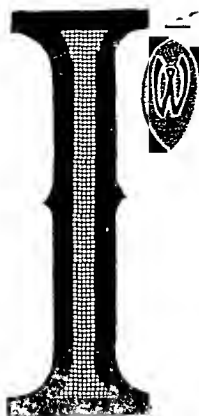
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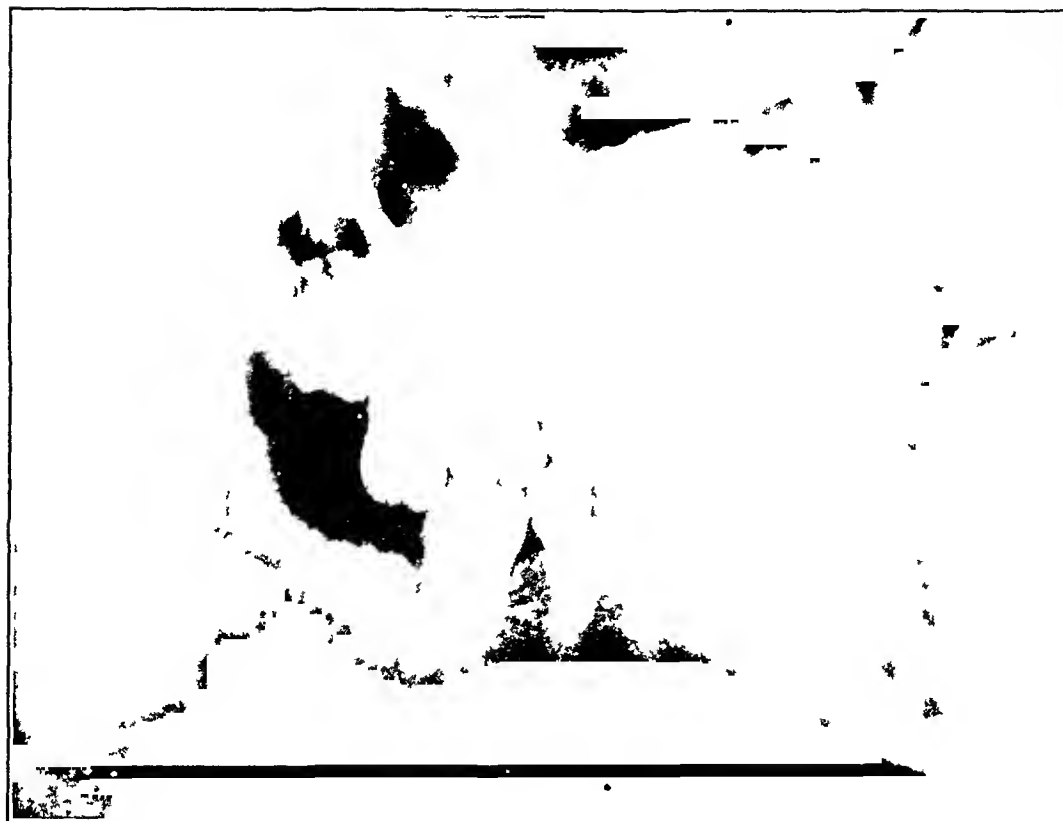
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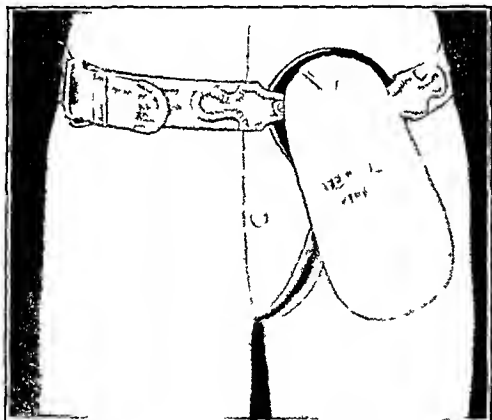


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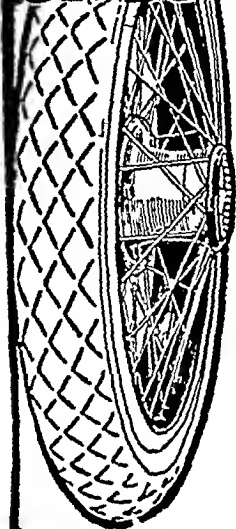
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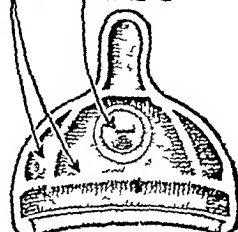
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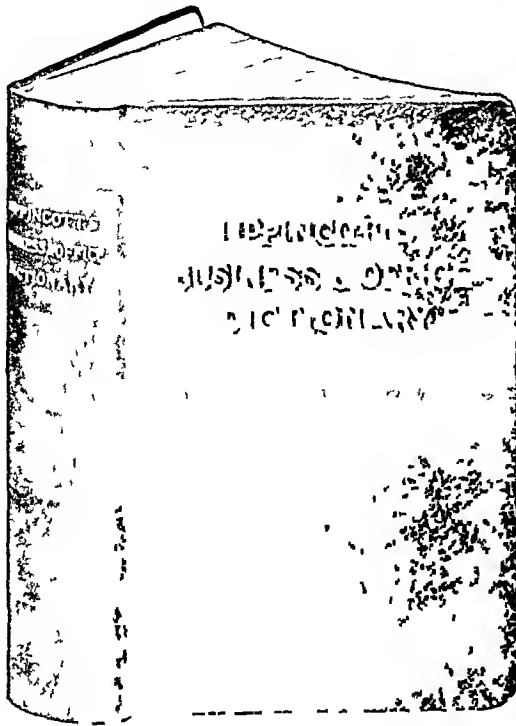
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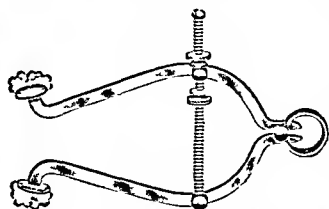
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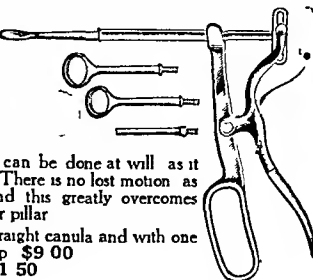
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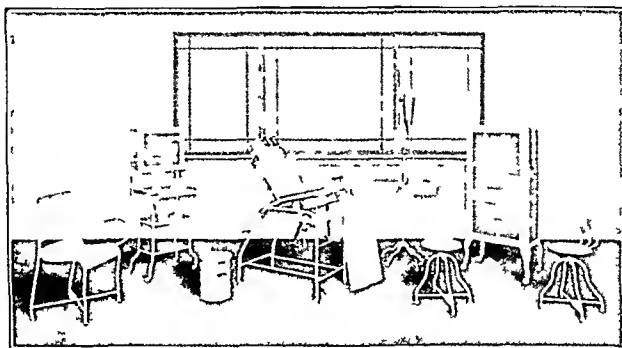


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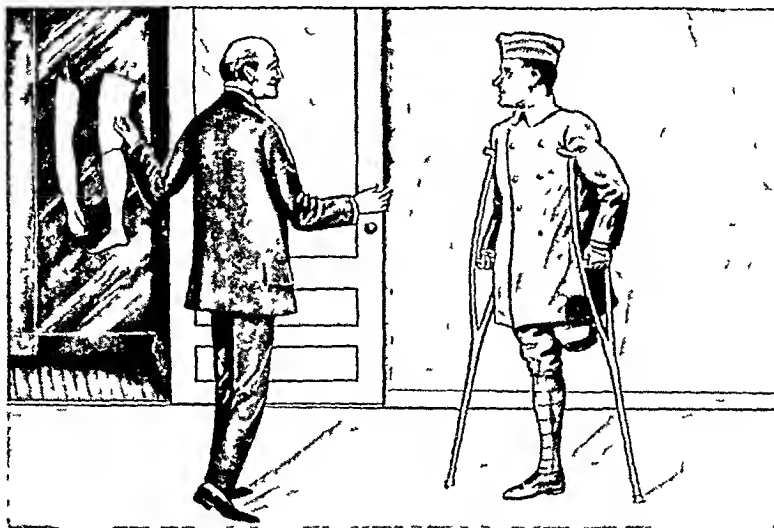
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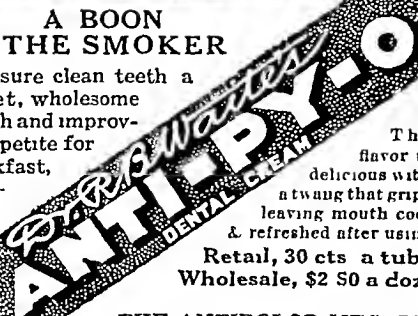
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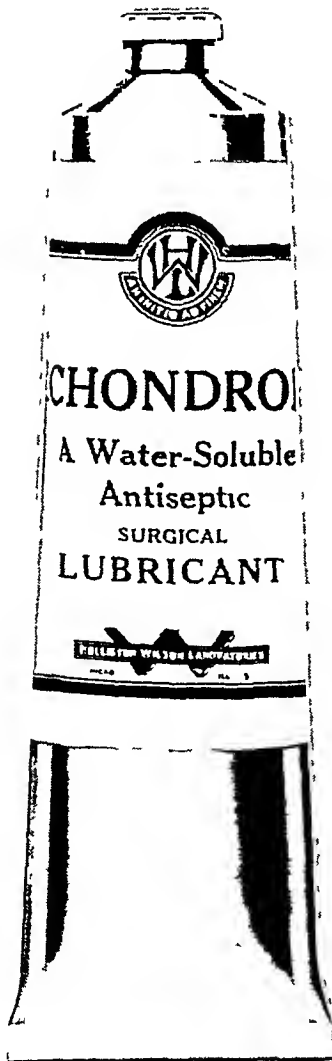
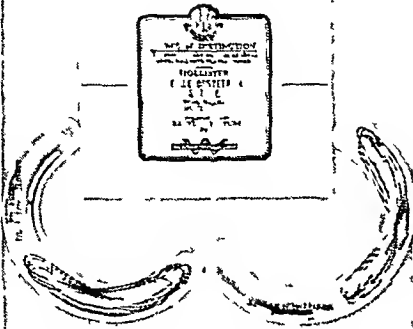
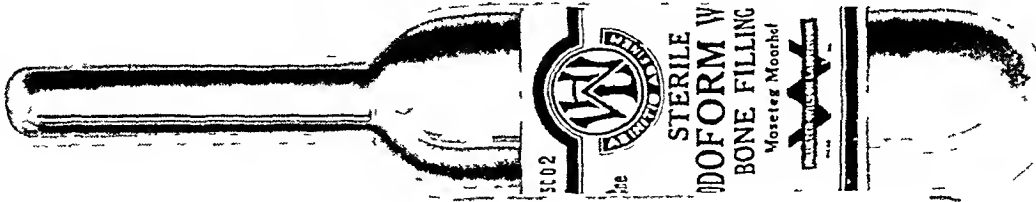
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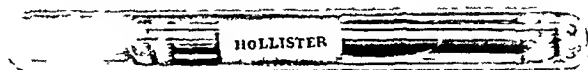
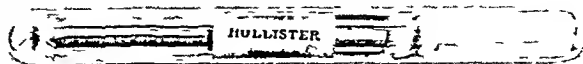
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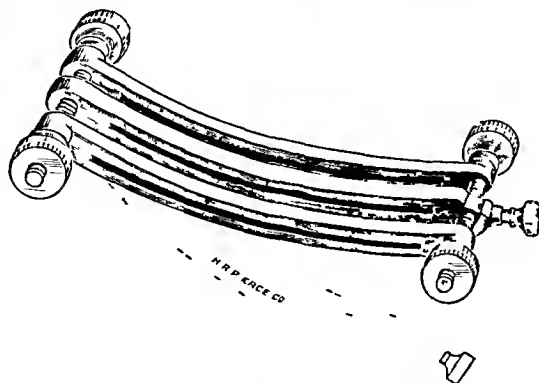


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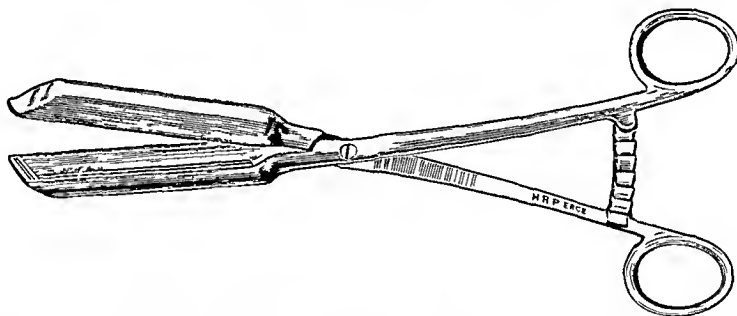
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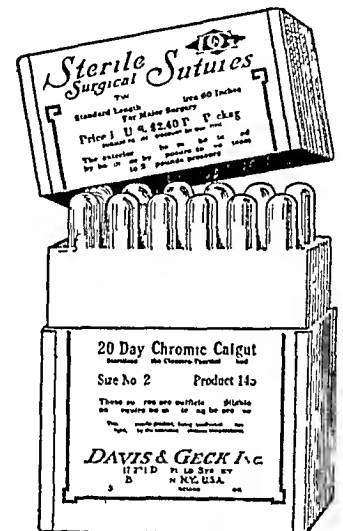
sutures but which were responsible for considerable wound irritation.

No other mode of sterilization so completely fulfills the exacting requirements for the production of ideal sutures as does the Claustro-Thermal method. Through its use the natural physical characteristics of the strands are preserved, while the destruction of all bacterial life is absolutely assured.

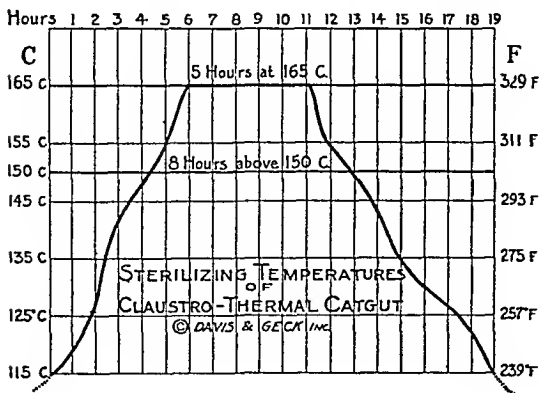
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The older practise of impregnating catgut with the ordinary crystalline iodine for this purpose was at best an unsatisfactory method, since the antiseptic power was but slight and transient. The most serious deficiencies of such iodized sutures, however, were their instability and weakness arising from exposure to light, the deterioration resulting from the continuous and unpreventable oxidizing action of the iodine, and the disintegration of the sutures when heated. Moreover, the decomposition products of iodine caused such sutures to be irritating.

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40-Day Chromic	Product No 1285	40-Day Chromic	Product No 1485

SIZES 000 00 0 1 2 3 4

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They are genuine kangaroo tendons, they are round, smooth, straight, of uniform contour, and possess a tensile strength about twice that of the best catgut of equivalent size.

Because of their greater strength some surgeons prefer these tendons to catgut particularly in the finer sizes, for general intestinal, muscle, fascia, and skin suturing.

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or in tendon for approximately thirty days. Shortly after that period the sutures, with their knots, will be completely absorbed.

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The **NON-BOILABLE** tendons are extremely pliable and consequently require no moistening.

The **BOILABLE** tendons are quite stiff as they come from the tubes, but may be rendered pliable by moistening in sterile water preliminary to use. The smaller sizes will be sufficiently softened by fifteen minutes immersion, while the larger sizes should be immersed for about thirty minutes. Either sterile water, or an aqueous bactericidal solution made with Kalmerid tablets—1 5000—should be used.

Before immersion, the toluol, which is very volatile, should be allowed to evaporate so that the water may have access to the sutures.

Reprints of original articles relating to Kalmerid sutures will be sent upon request.

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Each Tube Contains One Tendon Lengths Vary From 12 to 20 Inches

The Non-Boilable Grade is *Product No 370*

Boilable Grade is *Product No 380*

~ Sizes ~

Tendon Sizes	Ex Fine	Fine	Medium	Coarse	Ex Coarse
Catgut Sizes	0	2	4	6	8

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00	_____
0	_____
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2	_____
3	_____
4	_____
6	_____
8	_____

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360	Horsehair	Four 28-inch Sutures	00
390	Plain Silkworm Gut	Four 14-inch Sutures	00, 0, 1
400	Black Silkworm Gut	Four 14-inch Sutures	00, 0, 1
450	White Twisted Silk	60 Inches	000, 00, 0, 1, 2, 3
460	Black Twisted Silk	60 Inches	000, 0, 2
480	White Braided Silk	60 Inches	00, 0, 2, 4
490	Black Braided Silk	60 Inches	00, 1, 4
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812	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
822	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
862	Horsehair	Two 28-inch Sutures	00
872	Plain Silkworm Gut	Two 14-inch Sutures	0
882	White Twisted Silk	20 Inches	000, 0, 2
892	Umbilical Tape	Two 12-inch Ligatures	

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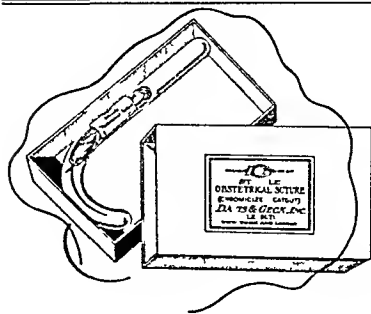
Product No	Material	Approximate Quantity in Each Tube	Catgut Sizes
904	Plain Catgut	20 Inches	00, 0, 1, 2, 3
914	10-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
924	20-Day Chromic Catgut	20 Inches	00, 0, 1, 2, 3
964	Horsehair	Two 28-inch Sutures	00
974	Plain Silkworm Gut	Two 14-inch Sutures	0
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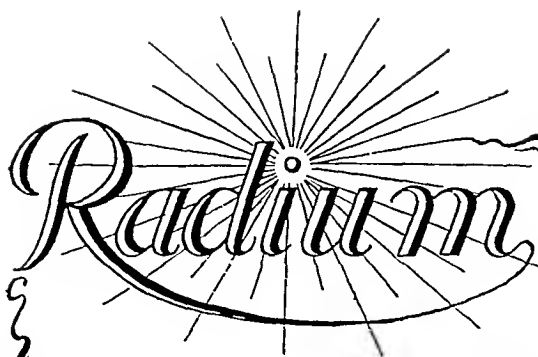
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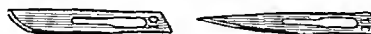
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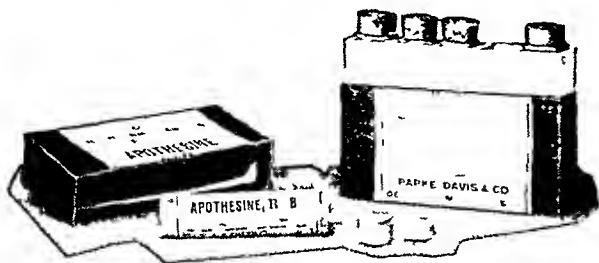
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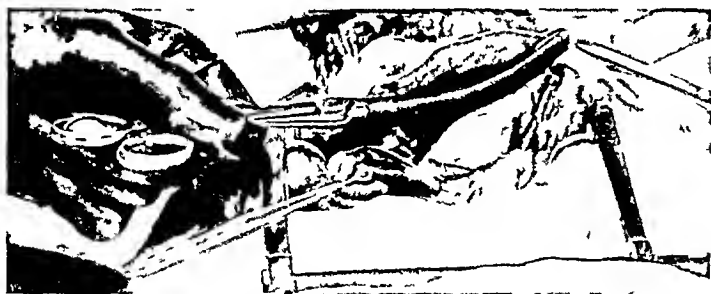
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ANNALS of SURGERY

Vol LXXI

MAY, 1920

No 5

FINGER EXPLORATION OF GUNSHOT WOUNDS OF THE BRAIN*

By EDWARD B TOWNE, M D
OF SAN FRANCISCO, CAL
LANE HOSPITAL

AND
THOMAS R GOETHALS, M.D
OF BOSTON, MASS

INTRODUCTION

OUR surgical team, while attached to Casualty Clearing Stations of the British First Army from May 12 to August 12, 1918, was designated to treat all wounds of the head admitted during a daily twelve-hour tour of duty. The casualties were received from a quiet sector in which no operations of major importance occurred, so that the Clearing Stations were not overworked, and it was never necessary to pass unoperated wounded along to the Base. That the opportunity for study of the cases was unusually favorable is indicated by the fact that the team operated only 262 casualties during the three months. The character, treatment, and mortality per cent of the 61 head wounds is shown in Table I.

TABLE I
Analysis of Cases of Gunshot Wounds of Head

	Number	Operated	Not operated	Died	Mortality %
Scalp wounds	22	22		1*	4.5
Fracture with intact dura	11	11		1*	9.1
Open dura with brain wound	28	20	8	7† 8	35 } 53.6 100 }
Totals	61	53	8	17	27.9

* Died of other cause than head wound
† One died of other cause than head wound

The 11 scalp wounds and 22 fractures with unopened dura brought out nothing of interest. The mortality in these cases is practically nil unless other wounds are fatal, as happened twice in this series. An intact

* From U S Army Base Hospital No 5
34 531

dura was incised once, and that case is included with those in which the dura was opened by trauma

This report is concerned with the 28 cases of wound of the brain of which 20 were operated and 8 were inoperable. The number of cases is limited, but a report seems justified for these reasons

1 The series includes every case of gunshot wound of the head admitted from a given sector in alternate twelve-hour intervals. The British system of evacuation provides for no sorting of casualties short of the Clearing Station, so that every grade of wounded, sick, and gassed is received. Our figures have some interest as being fairly representative of the proportion of the various degrees of cranial injury that survive to reach a hospital some 15 to 20 kilometres from the line under the existing conditions

2 We have been able to keep track of the 13 cases evacuated from the Clearing Station for periods of from six to twenty-one months after operation

3 Some of the recent papers on brain wounds have condemned the use of the finger for palpating foreign bodies in brain cavities. For this most important step of the operation we believe that finger palpation is the most rapid, sure, and safe method of cleaning a wound large enough to admit a finger, and it is particularly on this point that we wish to present evidence

The treatment of the wound in the brain tissue did not assume its true importance during the early years of the war. At first the general tendency, based on experience in previous wars in which bullet wounds predominated, was to abstain from operation. The disastrous results of this policy soon led to the conception that brain wounds should be opened widely and left open, and this was generally put into effect with more encouraging results. While dura and scalp were left open the method of cleaning the track attained relatively small importance, for, however thoroughly the metal, bone, and debris were removed, the wound was always subject to the danger of secondary infection during the long process of granulation and cicatrization, and one could never be certain whether the encephalitis in a given case was the result of imperfect cleaning or of infection from without. With the acceptance of the principle of primary suture of the scalp the situation became quite different, for if a brain wound operated early became septic under a sutured scalp it was clear that the track had not been properly cleaned. It was not until 1917 that suture came into its own, and then largely because it had been successfully applied primarily or secondarily to wounds of soft parts and of joints. There had been prophets before this, and largely without honor, as one looks back it seems extraordinary that the results of suture in the hands of Barany,⁵ Tabuteau,³⁵ and Velter³⁸ did not establish the method at once

In the spring of 1918 we felt convinced, from previous experience and from the scanty available literature, that craniocerebral wounds should

be operated under local anæsthesia at the earliest possible moment, that damaged scalp and bone should be removed, that any evidence of skull injury demanded exploratory trephining, and that after cleaning of the track and removal, if possible, of foreign bodies the scalp should be closed. The open question was how the contaminated brain pulp, blood-clot, metal, detached bone fragments, cloth, and hair could be removed from the brain cavity surely, expeditiously, and without addition to the existing amount of brain damage. On this point we knew from experience with Cushing's team in the fall of 1917 (Cushing^{9, 10}) that he opposed the use of the finger in the brain cavity, and advocated exploration with a soft rubber catheter and removal with forceps or magnet of the foreign bodies thus detected. This procedure was prolonged and tedious—Cushing says, "At best most of the critical operations deservedly require upward of a two-hour period"—and, more important, was sometimes unsuccessful in that it failed to remove all the foreign bodies. On the other side of the question we knew that Gray¹⁰ and his followers were strong advocates of finger palpation in proper cases. For example, Anderson³ says, "It is found that the brain does not suffer from careful exploration by the finger, if the hole in the dura permits of its introduction fairly easily."

A certain amount of personal experience, both pathological and clinical, had influenced our views on this question. A number of postmortem examinations of cases dying within twenty-four hours of injury impressed us strongly with the fact that it was a mistake to consider the brain lesion a *track* whose size was little, if any, greater than the diameter of the metallic fragment. The lesion was in reality a *cavity* in the brain tissue, with a diameter always considerably greater than that of the dural opening, which usually corresponded roughly to the size of the largest lodging foreign body. This cavity was somewhat egg-shaped, with the dural aperture at one pole, and the metal at the other, and with showered bone fragments lying free or embedded in its walls. The lesions observed in cases that died without operation indicated that, though the impulsion of bone fragments at angles lateral to the direct course of the metal was one reason for the increased diameter, the pressure of the hæmatoma which invariably filled the cavity caused additional lateral expansion. The same egg-shaped loss of substance was noted in lesions caused by indriving of bone fragments alone, and in the region of entrance of bipolar wounds—in fact, wherever bone fragments were found. We concluded that it was theoretically possible to palpate such cavities with the finger without any risk of causing additional injury to the surrounding uninjured brain tissue, and we felt that the prospect of being able to remove foreign bodies rapidly and completely was so desirable as to justify a trial, particularly as the method had been approved by surgeons of good standing. Therefore, it was used in a small series of unoperated cases which came into the hands of one of us (E. B. T.) in the fall of 1917. One case will be given to illustrate how the theoretical conclusions were confirmed.

CASE A—Pte J P *Left parietal wound with prolapsed brain Paralysis right arm and leg except for slight power in glutei Paresis right face Astereognosis right hand, loss of joint sense right fingers X-ray—metal lodged in fractured skull, no undriven bone seen*

Operation (October 15, 1917)—Ether Tourniquet Linear excision of scalp wound Metal and bone fragments removed from brain fungus Skull trephined and rongeur away to expose dural edge Track cleaned by suction and irrigation with catheter and syringe By Cushing's technic five pieces of bone were detected with the catheter and removed with forceps When no more could be felt the finger was introduced through the dural opening and palpated the walls of an egg-shaped cavity 5 cm deep Two bone fragments, each over 1 cm in diameter, were detected in the wall of the cavity and removed with forceps Hæmostasis secured by irrigation with hot normal salt solution Scalp closed with two gutta percha tissue drains between stitches

Post-operative Course—Motor and sensory condition on day after operation exactly as before On fifth day there was improvement in face, deltoid, biceps, thigh muscles, and flexors of ankle On tenth day there was motion in flexors of wrist and extensors of ankle On fifteenth day all motions of arm and leg were performed with fair strength except at and below wrist and ankle, where they were weak Face still weak Wound healed Evacuated to England October 29th March 2, 1918, report from National Hospital, Queens Square, London (kindness of Dr Fred S Batten) "Wound sound, walks quite well, still has almost complete astereognosis of right hand Power of right hand fair—right arm good Except for this post central loss is quite well"

In three other cases foreign bodies were removed from cavities in the frontal lobe, temporal lobe, and cerebellum, and in each instance more bone fragments were detected by the finger after prolonged attempts to extract everything with catheter and forceps These three also healed and were evacuated in good condition, and in none of them was there any evidence of increased brain damage after operation The case detailed above was, however, the most encouraging evidence in favor of the finger technic, in that marked signs of injury to the motor tracts were not accentuated by operation, improved steadily, and disappeared almost entirely in four and one-half months

REPORT OF CASES

All wounds of the brain received at a forward hospital are not operable, nor do the operable cases all have large enough loss of cerebral substance to make finger palpation of the cavity possible The 28 cases to be reported will therefore be classified under these headings

- 1 Inoperable Cases (8) 2 Operated Cases (20)
- a Cases in which finger palpation was not indicated (9)
- b Cases in which finger palpation was or might have been used (11)

FINGER EXPLORATION OF BRAIN WOUNDS

I THE INOPERABLE CASES—All but the obviously dying were operated, as it was felt that intervention without a general anæsthetic could do no harm, and might offer a chance of life to even the deeply comatose. As will be seen later, at least 3 of the operated cases were actually quite hopeless, but in a condition which appeared to justify intervention. Of the 8 cases which were not operated, 7 died in less than five hours, and 1 in ten hours after admission. All showed profound coma, a pulse of 110 to 140 which was weak and irregular, stertorous respiration which was frequently rhythmic, and loss of sphincter control, the majority were also sweating and frothing at the lips. One case will suffice to illustrate.

CASE I—Rfm A B Admitted June 10, 1918 *Large left parietal wound with prolapsed brain*. Deeply unconscious. Pulse 128, weak and irregular, Cheyne-Stokes respiration, froth on lips, skin moist and cold, involuntary urination. Dressed and sent to resuscitation ward, where he died two and one-half hours later. Autopsy. Extensive loss of substance left parietal lobe, track passing through lateral and third ventricle, large shell fragment at base in right middle fossa, bone fragments in left hemisphere and lateral ventricle.

2 THE OPERATED CASES—*a Those in Which Finger Palpation was not Indicated*. Widely different pathological conditions, such as areas of cortical laceration and hemorrhage covered by intact or punctured dura, tracks caused by very small metallic fragments which lodge or perforate, or inaccessible areas of brain damage caused by missiles passing through the deeper nasal sinuses, may come under this heading. In some of these conditions the treatment is quite simple, but in others, especially the lodged metallic fragments of small diameter and the brain wounds communicating with a nasal sinus, the prospect of encephalitis is always disturbing and its avoidance most difficult or even impossible. In this group are assembled 9 operated cases, 3 of which died.

CASE II—Pte B W *Area of laceration and hemorrhage in motor cortex under intact dura evacuated. Rapid amelioration of paralysis and aphasia. Weak face and mental changes twenty-one months later*. Admitted May 26, 1918, at 9 A M (five hours after injury). Conscious, pulse, 84, warm, severe headache.

Wounds—(1) Crescentic scalp wound 3.5 cm long, located 15/32 and 8 cm to left*. (2) Gutter wound with incomplete fracture left tibia. (3) Lodging wound right calf, large hæmatoma. X-ray—fracture skull, no metal, partial fracture right tibia with many small metallic fragments.

Neurological—Twitching right face with central type paralysis. Paresis right arm, astereognosis right hand. Motor aphasia and agraphia, understands spoken and written words.

* By this method of localizing cranial wounds a base line is measured from nasion toinion (32 cm), a perpendicular is run from it to the centre of the scalp wound (8 cm), and the distance from the nasion to the point where the perpendicular intersects the base line is measured (15 cm).

Operation—May 26th, 11 A M (seven hours) (1) Novocaine and adrenalin Scalp and pericranium excised, wound enlarged in three directions, flaps turned back Shallow groove 1 cm long in external table trephined, bone cut away to limits of fracture of internal table (3 cm opening) Dura intact, tense, deep purple, and immobile A 2 cm linear incision was made, allowing a large amount of pulped brain and clot to extrude Bleeding pial vessels secured with silver clips Shallow cavity sucked clean and irrigated with hot saline solution Dura, fascia, and skin sutured No drainage (2) Spinal anæsthesia Wound left leg excised and sutured Wound right leg excised, bone and metallic fragments removed, partly severed posterior tibial vein ligated, light gauze pack and splint

Post-operative Course—May 28th Twitching of face rare Hemiparesis unchanged Can say a few simple words Wounds clean Scalp sutures removed June 1st—No twitching face Arm stronger Chloroform, wound of right leg sutured, splint June 2d—Cultures from right leg—no growth June 4th—Talking better, able to write name and address Right arm improving, can move right corner of mouth a trifle Left leg healed, sutures removed June 11th—Right leg healed, sutures removed Talks and writes slowly and with mistakes, but with steady improvement Right arm almost normal, right face weak All wounds healed No headache Evacuated to Base

Later Reports—March 19, 1919 (nine and one-half months) Letter from patient, well written Working in flax mill Occasional mild headaches and dizziness Right arm normal Right corner of mouth droops a little "I don't speak properly when tired" February, 1920 (twenty-one months) Letter from wife Same status, except for four short periods when he was mentally deranged, thought her a German and threatened to kill her and himself

Comment—On the much debated question whether or not to incise an intact dura it seems to us that given a case under twelve or fourteen hours, there is very little danger of infection, and that the advantages of evacuating the pulped brain and hæmatoma and of securing the bleeding vessels are probably important though difficult to prove Certainly in some instances it is necessary to check the hemorrhage if real danger of medullary compression is to be averted

CASE III—Pte E G T *Laceration of post-central cortex by bone fragments projected through dura Slight residual motor and sensory loss eleven months later* Admitted May 30, 1918, at 1 P M (ten hours after injury) Headache, dizziness, nausea, and three attacks of twitching in left arm without loss of consciousness Pulse, 84, warm, rational

Wound—1 by 1.5 cm, its centre located 19/34 and 4 cm to right X-ray—metallic fragment in fractured skull

Neurological—Left-handed individual Left arm weaker than right Loss of common sensation left forearm Astereognosis left hand Loss of joint sense left shoulder, elbow, wrist, and fingers



Fig 1—Case III External and internal aspects of bone block and undriven fragments, a bullet struck in by shell fragment (Natural size)



Fig 2—Case XIII Lead shrapnel ball lodged in skull (Natural size)

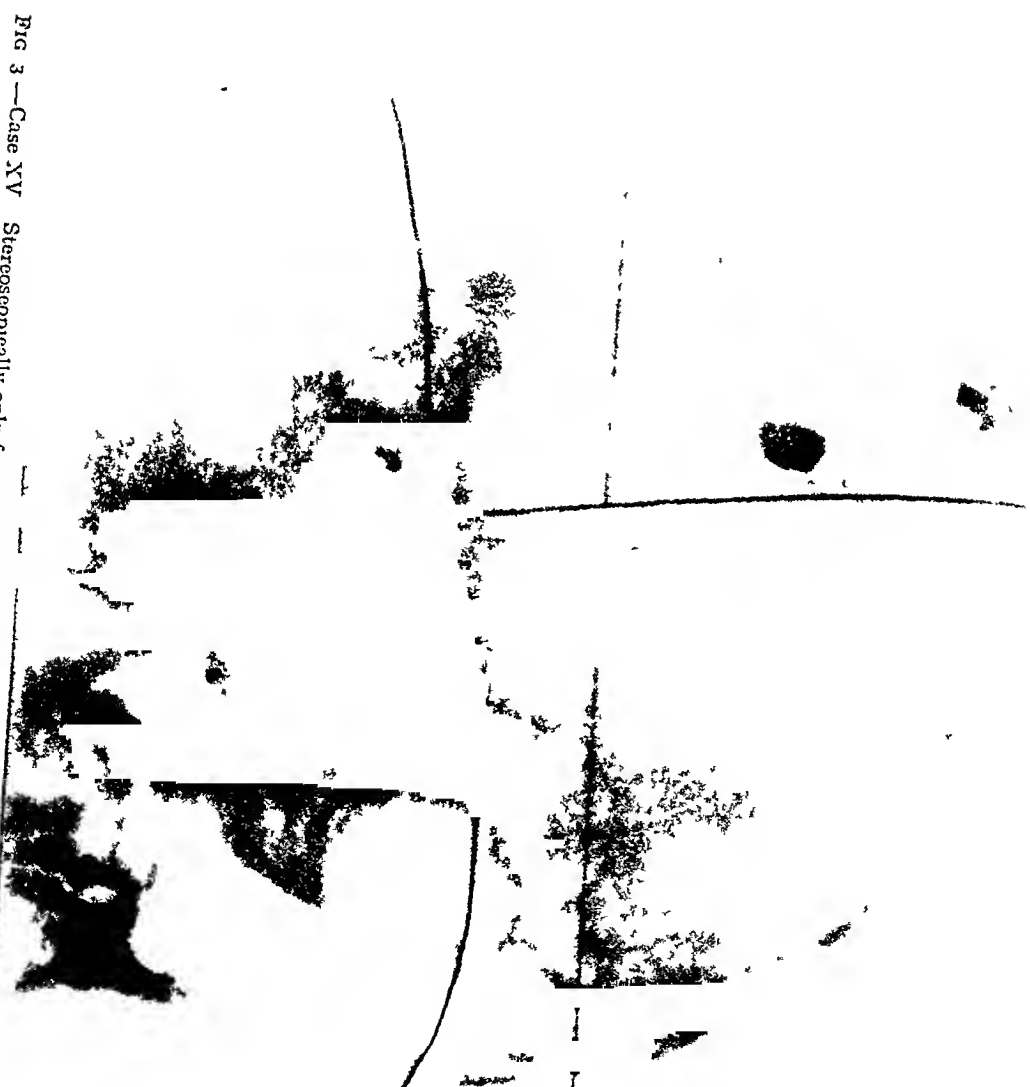


Fig 3—Case XV Stereoscopically only four undriven bone fragments could be identified (See Fig 4)



FIG 4 —Case XV Internal aspect of bone block and foreign bodies removed from brain cavity. a metallic fragment—a piece of German helmet (Natural size)

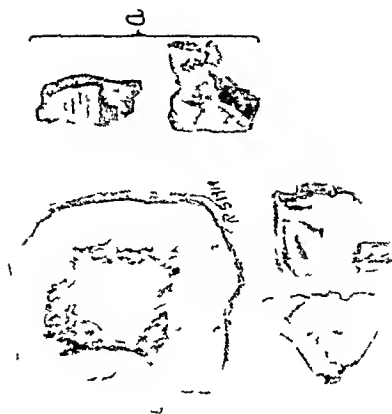


FIG 5 —Case XVI Internal aspect of bone block the larger bone fragments and (a) two views of the shell fragment. The metal and largest bone fragment were extracted from the lateral ventricle (Natural size)

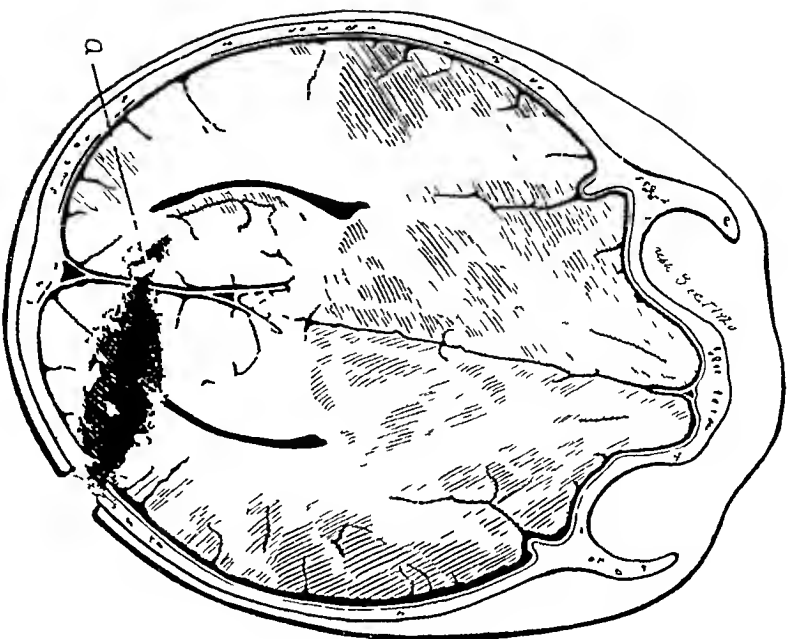


Fig 6—Case XVII Dagrammatic horizontal section to illustrate egg shaped cavity in right occipital lobe with bone fragment in ventricle Metallic fragment (a) was extruded through hole in falx

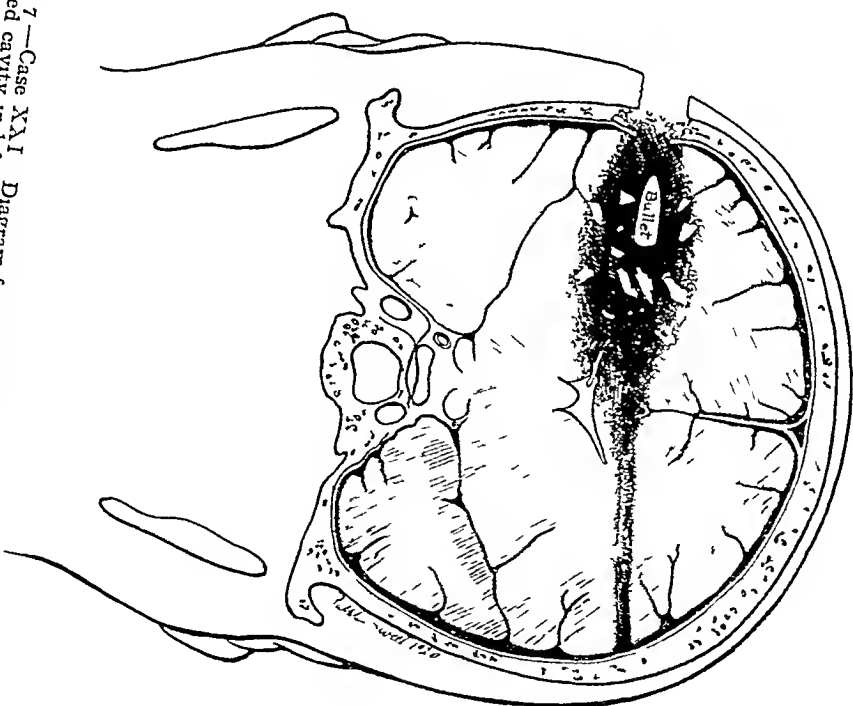


Fig 7—Case XXI Diagram from sketch at autopsy Note egg-shaped cavity in left hemisphere open ventricle, severed anterior cerebral artery and position of bullet before operation

FINGER EXPLORATION OF BRAIN WOUNDS

Operation—May 30th, 5 P M (fourteen hours) Novocaine and adrenalin Scalp wound excised and extended in three directions The shell fragment had carried into the bone a piece of burlap helmet-cover (Fig 1) Block of bone cut out, edges trimmed Three pieces of bone, removed with forceps from just within a 1 cm tear in dura, completed pattern of inner table Small cortical cavity cleaned by suction and irrigation Dura, fascia, and skin sutured During operation there were three attacks of twitching of left arm, each lasting about thirty seconds

Post-operative Course—June 1st—Paresis of arm improving Skin sutures removed June 8th—Weakness of arm scarcely detectable Joint sense of elbow and shoulder normal Other sensory loss unchanged Wound healed No headache Evacuated to Base

Later Reports—April 24, 1919 (eleven months) Letter from patient In good health and working Occasional headaches Left arm a trifle weak, and "proper sense of feeling has not yet returned" No epilepsy

Comment—The only feature of interest is the good illustration of how contaminated foreign matter—in this instance a piece of the burlap which was so frequently used to cover "tin hats" in hot weather—may be carried in by a missile The prognosis for continued freedom from epilepsy is dubious

CASE IV—Pte S C S *Deeply lodged small metallic fragment not recovered Incapacitated by headache twenty months later* Admitted June 7, 1918, at 10 A M (eleven and one-half hours after injury) Severe headache, pulse, 80, no neurological symptoms

Wound—0.5 cm in diameter located 24/34 5 and 13 cm to right X-ray—a metallic fragment 0.3 by 0.7 cm in midline half way between base and vertex

Operation—June 7th, 2 P M (fifteen and one-half hours) Novocaine and adrenalin Scalp wound excised, small block of bone containing 0.5 cm defect cut out Pulped brain sucked out of track with small catheter, which passed in 10 cm without detecting a foreign body or draining cerebro-spinal fluid Dura and scalp sutured

Post-operative Course—June 8th—Severe headache Spinal puncture, 40 c c of blood-stained fluid Cultured—no growth June 9th—Sutures out June 11th—Severe headache, temperature and pulse normal, no tension in wound Spinal puncture, 45 c c June 16th—Headache less severe Wound healed Evacuated to Base

Later Reports—February 16, 1920 (twenty months)—headache and dizziness quite severe, leading quiet life and not working on medical advice

Comment—The location of the wound and of the metallic fragment makes it practically certain that the lateral ventricle was involved, though this could not be confirmed at operation Such cases are unsatisfactory in that they accomplish little beyond partially cleaning the track

and closing the coverings of the brain, it is then merely a matter of chance whether or not the foreign bodies cause sepsis

CASE V—Bdr D McM *Laceration of temporal lobe by missile that passed through eye and maxillary sinus Good result six months later* Admitted August 12, 1918, at 2 A M (ten hours after injury) Good general condition, no neurological symptoms Wound of right face, eye destroyed, malar bone and floor of orbit fractured X-ray—large metallic fragment in right sphenomaxillary fossa

Operation—August 12th, 4 A M (twelve hours) Chloroform Eye enucleated, fractures of malar bone and floor of orbit regulated, metal removed Fragments of fractured great wing of sphenoid picked out Catheter passed into a temporal lobe cavity which was sucked as clean as possible No indriven bone felt, finger palpation not possible Gutta percha tissue drain to dura through stab wound in temporal muscle Fractured malar bone replaced by suturing periosteum, plastic closure of cheek and eyelids

Later Reports (not seen after operation)—Letter from Medical Officer who took charge of patient, "evacuated to Base September 2, 1918, in good condition with apparently complete recovery" February 23, 1919 (six months)—reply card from hospital in Scotland "Pus in eye socket on admission Antiseptic lotions, massage Sent on extended leave Result Socket clean and cheek swelling down"

Comment—Favorable results in these nasal sinus cases are largely a matter of good fortune, for the brain cavity usually cannot be properly cleaned and is, moreover, exposed to secondary infection

CASE VI—Pte J G *Unsuspected exit wound over occipital lobe, entrance not identified In hospital because of headache six months later* Admitted August 9, 1918, at 9 P M Good general condition, conscious and irritable No neurological signs Multiple small wounds of scalp, face, thighs and legs X-ray—no metal in head

Operation—August 9th, 11 P M (interval not noted) Chloroform Two scalp wounds excised and sutured A third, over right side of occipital bone aboveinion, exposed a 0.6 cm bone defect which was obviously an exit wound, as there were bone fragments in the scalp Opening enlarged, catheter passed 3 cm along a track directed toward left ear when it met obstruction (falx?) Dura and scalp closed Metal removed from thigh and leg wounds

Post-operative Course—August 12th—Wounds clean, temperature and pulse normal, rational and irritable Reëxamination discloses no entrance wound of left face, neck or mouth No hemianopsia on rough test (Not seen after this date)

Later Reports—March, 1919 (six months)—letter from patient In hospital in England Wounds healed Under treatment for "periodical pains in the head"

CASE VII—Pte F W *Wound perforating right cerebellum Evacuated to England as walking case sixth week Working twenty*

FINGER EXPLORATION OF BRAIN WOUNDS

months later Admitted June 15, 1918 Good condition, conscious and irritable

Wounds—Entrance right cheek, exit half way between right external auditory meatus andinion, at level of meatus Bone fragments in scalp, prolapse of brain tissue

Neurological—Right seventh nerve branch to forehead paralyzed, right ear deaf, dizzy, slight dysarthria

Operation—June 15th (ten hours) Novocaine and adrenalin Exit wound excised, margins of bone defect regulated, track in cerebellum sucked and irrigated, scalp sutured with small gutta percha tissue drain to dura

Post-operative Course—June 17th—Sutures and drain removed Moderate headache June 23d—Neurological signs unchanged, wounds healed, no headache Evacuated to Base

Later Reports—July 23, 1918, from Base in France "Evacuated (that day) as walking case Walks well with slight shuffling right foot Speech much clearer Ataxia of right hand much less Very little dizziness or headache" February, 1920 (twenty months), by letter from Colonel Gordon Holmes right ear deaf, infrequent severe headaches, right hand useful "except for little things that require a light touch" (patient's words)

The Fatal Cases—Three cases in Group A resulted in death The first did not die of his brain wound

CASE VIII—Pte G H *Multiple wounds, including depressed fracture temporal bone with cortical laceration by indrwn bone fragments Death from post-pleuritic empyema Brain wound clean* Admitted June 9, 1918 at 8 A M (seven hours after injury) Semi-conscious, restless, and noisy, pulse 104, poor quality, no neurological symptoms

Wounds—(1) Over nasion, M F felt in left orbit, left eye destroyed (2) Four right parieto-temporal scalp wounds, under one of which, just above auricle, fractured bone is seen (3) Two lodging wounds right shoulder X-ray—fracture right temporal bone, metallic fragments in right deltoid and supraspinatus and in left orbit

Operation—June 9th, 11 A M (ten hours) Chloroform (1) Right parietal and temporal scalp wounds excised, depressed fracture temporal bone trephined, small dural tear enlarged, three fragments of bone removed with forceps from under dura, area of contusion cleaned, dura sutured, plastic scalp flap (2) Nasion wound excised and extended along left supraorbital ridge Fracture into left frontal sinus regulated, mucous membrane curetted out of sinus Left eye enucleated, metal removed from orbit (3) Metal and damaged tissues removed from right shoulder region

Post-operative Course—Normal as concerns wounds, which were all clean June 11th—Pleurisy right chest June 13th—Pus aspirated from chest June 17th—Doing badly despite daily aspirations June 18th—Empyema drained June 23d—Died

Autopsy—Area of laceration in right temporal lobe clean and

covered with healed dura and scalp. A little pus in left orbit, frontal sinus clean. A 2 cm area of organizing hemorrhage in left parietal cortex (contrecoup). Shoulder wounds clean. Right empyema and lung collapse, small abscesses near surface of lung.

CASE IX—Sapper G A F. *Small metallic fragment, penetrating frontal sinus, third ventricle, and basal ganglia, not extracted. Death fifth day from ventriculitis.* Admitted July 22, 1918, at 3 P M. Semi-conscious, irritable, and noisy, pulse 80 and fair quality, no neurological symptoms.

Wound—Small puncture through left eyebrow. X-ray—metallic fragment 0.4 by 0.8 cm lying 2.5 cm posterior to dorsum sellæ and 3 cm to right of midline.

Operation—July 22d, 6 P M (interval unknown). Chloroform. Scalp wound excised and extended. Anterior wall of left frontal sinus removed, mucous membrane curetted out of sinus, opening in posterior wall of sinus enlarged. Small catheter sucked track to depth of 6 cm without detecting a foreign body. At one point a few c c of blood-stained fluid were aspirated from a ventricle. Scalp sutured.

Post-operative Course—July 24th—Extremely noisy and irrational. Temperature and pulse normal. July 27th—Temperature 101°, pulse 150, respiration 32. Chest negative. Incontinence of urine. Wound healed. Spinal puncture, 20 c c of yellow clear fluid (pure culture streptococcus). Died 9 P M.

Autopsy—Frontal sinus clean, fronto-nasal duct open. No gross meningitis or encephalitis. Two small bone fragments just below dural opening. Track passed through left frontal lobe, crossed midline above optic chiasm, and traversed third ventricle. Metal lay between right crus and optic thalamus.

Comment—The gross appearance of meninges and brain was so normal that but for the streptococci in the spinal fluid the death might have been attributed to midbrain injury. The striking similarity between this and Case IV, which recovered, shows how large an element chance plays in the results of these imperfectly cleaned cases.

CASE X—Pte T F. *Perforating wound through nasal sinuses and temporal lobe. Death eighth day from meningo-encephalitis.* Admitted August 10, 1918, at 8 P M. Semi-conscious and irritable, bleeding from nose, no paralysis, left pupil dilated and fixed, pulse 76 and good quality.

Wounds—Perforating, right cheek to above left zygoma, with blown-out bone fragments in left temporal muscle.

Operation—August 10th, 10 P M (interval not known). Chloroform. Damaged scalp and temporal muscle excised. Finger palpated a fracture of great wing of sphenoid at base but could not reach area of brain laceration. Catheter introduced and suction applied. Wound sutured with gutta serena tissue drain to dura. Cheek wound excised and sutured.

Post-operative Course—August 12th—Rational, drowsy Temperature and pulse normal (Not seen after this date, further information from Medical Officer who took charge of case) August 16th—Headache, rising temperature and pulse August 18th—Died

Autopsy—Track through infected right maxillary sinus, floor of nose, left maxillary sinus Fracture of left great wing of sphenoid Abscess in left temporal and frontal lobes Meningitis over entire left cerebral hemisphere

Comment—Case V, which did not become septic, had almost the same pathology and treatment There appears to be no way to reduce the risk which patients with such awkwardly situated brain lesions must undergo

b CASES IN WHICH FINGER PALPATION WAS OR MIGHT HAVE BEEN USED—Under this heading there are 11 cases, of which 7 recovered and 4 died In all but one finger palpation was used, and that one, which follows, was the only instance of infection and brain fungus which occurred among the cases in which the foreign bodies were within reach of the finger

CASE XI—Pte E W *Cavity in frontal lobe imperfectly cleaned by Cushing's technic Infected fungus cerebri Severe epilepsy began twelve months later* Admitted May 13, 1918, at 9 A M (twelve and one-half hours after injury) Cold, semi-conscious, and irrational, pulse 80 and poor quality, no neurological symptoms

Wound—A narrow gutter 5 cm long following hair line in right frontal region Brain tissue prolapsed X-ray—indriven bone, no metal Sent to resuscitation ward At 2 P M warm, conscious, with good pulse of 90

Operation—May 13th, 3 P M (eighteen and one-half hours) Novocaine and adrenalin Scalp wound excised and extended in three directions exposing 1 by 4 cm defect in frontal and temporal bones Edges rongeuired to uncover margins of a 3.5 cm tear in dura By patient's efforts, suction, and irrigation, pulped brain and clot were evacuated from a cavity 4.5 cm deep Seven bone fragments with diameters 5 to 1.5 cm were detected with catheter and removed with forceps The finger was not introduced Scalp closed with gutta percha tissue drain to dura

Post-operative Course—May 16th—Sutures and drain removed May 18th—Small fungus through scalp at junction of flaps, temperature and pulse normal Spinal puncture, 30 c.c. clear fluid (no growth) May 20th—Pus from drainage wound grew streptococci, staphylococci, and B. Welchii May 23d—Fungus 2 cm in diameter and level with skin, discharging small bone fragments May 31st—Fungus receding and granulating No headache Temperature and pulse normal Evacuated to Base

Later Reports—June 15, 1918, from Base in France "Moderate infection of granulating surface One or two small spicules of bone picked out No intracranial symptoms" February 23, 1919 (nine and one-half months), letter from patient—Unable to resume work as miner because of dizziness when stooping Otherwise perfectly well

January 9, 1920 (twenty months), letter from sister—General epilepsy without aura began May, 1919, attacks once a month lasting five minutes Face severely burned during convulsion in December, 1919

Comment—In spite of the fact that we were convinced that such a brain cavity, especially in a silent area, could be properly cleaned by the finger technic without risk of further brain damage, we felt impelled to try the catheter method once more The notes do not give the time consumed in the procedure, but it was very long and tedious This was our first Clearing Station case in which the finger might have been used, and the only one in which we failed to use it The six and one-half hours delay between admission and operation was not wise or necessary, we soon discovered that a man in like condition could usually be warmed and made ready for operation in an hour by the application of external heat and the administration of hot drinks Whatever influence the eighteen and one-half hour interval may have had (and it was probably not important, for similar cases operated after fourteen to sixteen hours and completely cleaned did not become septic), the fact remained that we had failed to remove all the bone fragments, and that the man recovered only because he was able to take care of his sepsis The next case offers an interesting contrast

CASE XII—Pte J P *Cavity in frontal lobe from tangential wound involving frontal sinus cleaned under finger control Free from discomforts and working twenty months later* Admitted May 16, 1918, at 9 A M (five and one-half hours after injury) Condition good, restless and irritable, right eye blind

Wound—Through middle of right eyebrow, oozing brain tissue Large metallic fragment felt under scalp

Operation—May 16th, 11 A M (seven and one-half hours) Chloroform Triradiate incision, bone defect enlarged to uncover dural margins, loose fragments of roofs of right orbit and frontal sinus removed, mucous membrane curetted out of frontal sinus After suction and irrigation of a cavity 4 cm deep, the finger was introduced and five pieces of bone were removed from its depths with forceps Scalp sutured with gutta percha wick to dura

Post-operative Course—May 17th—Ectropion of right upper lid Right pupil dilated with atropin. May 19th—Sutures and wick removed May 22d—Two short general convulsions May 23d—Drowsy, complains of headache Spinal puncture, 45 c c May 27th—Right eye counts fingers, can almost close right eyelids No headache, wound healed Evacuated to Base

Later Reports—May 29, 1918, from Base Hospital in France "No headache—extensive hemorrhages in right vitreous" February, 1919, and January, 1920 (twenty months), letters from patient's father—Working as warehouseman in a factory, almost no vision right eye, "he is in splendid health and spirits"

CASE XIII—Pte F G W *Laceration of speech area by bone fragments projected from a tangential wound Finger technic Jack-*

FINGER EXPLORATION OF BRAIN WOUNDS

sonian epilepsy began tenth month Admitted July 27, 1918, at 6 A M (seven hours after injury) Severe headache, good general condition

Wound—Left parietal (not localized) No brain tissue seen X-ray—shrapnel ball in fractured skull

Neurological—Alexia, agraphia, impaired understanding of spoken word, and slow groping speech

Operation—July 27th, 11 A M (twelve hours) Novocaine and adrenalin Triradiate incision, exposing a lead shrapnel ball lodged at one end of a gutter defect (Fig 2) Block of bone excised, eleven extradural bone fragments removed There were two small openings in a tense, purple, immobile dura A connecting incision was made, allowing a quantity of pulped brain and clot to extrude Suction and irrigation of a shallow cortical defect, finger palpated three bone fragments embedded in the wall of the cavity, which were removed Pial vein ligated with clip Dura, fascia, and skin sutured

Post-operative Course—July 29th—Headache, wound rather tense Spinal puncture, 40 c.c. (no growth) Speech defects unchanged Skin sutures removed August 7th—Wound healed, no headache Alexia unchanged, can write alphabet, speech hesitating because of difficulty in remembering words, understands spoken word perfectly Evacuated to Base

Later Reports—Letters from patient and his mother November, 1918 (four months), went to work as miner underground Aphasic condition entirely gone May, 1919 (ten months), minor convulsions involving right side June, 1919, a cranioplasty was done August, 1919, a series of severe general convulsions, apparently focal in right arm, returned to hospital January, 1920 (seventeen and one-half months), working above ground Major convulsions every six weeks, ushered in by herniation at defect where graft has not united Medicines have had no effect "Very bright and cheerful" between attacks Awaiting word to return to hospital, where he believes bone graft is to be attempted again

Comment—The interesting point in this case is the epilepsy following suture of the dura It would seem unwise to allow a man with a wound so near the motor cortex to attempt the heavy work of a miner On the question of cranioplasty, it is difficult to see how one could expect to cure or improve epilepsy by repairing a skull defect One of Guillain's¹⁹ conclusions, as adopted by the Society of Neurology of Paris, was that cranioplasty is contraindicated if the patient shows partial or general epileptic phenomena In this instance the convulsions became much more severe and frequent after the attempted repair, but it is impossible to say that the course would not have been the same without operation It seems unlikely, in view of the history of herniation of a tense brain with the onset of the attacks, that the patient is correct in thinking that cranioplasty is to be again attempted, probably the dead graft is to be removed

CASE XIV—Pte E D *Shallow temporal lobe cavity containing foreign bodies contaminated with gas bacillus and streptococcus* Flap

operation, finger technic Working as miner twenty months later Admitted June 12, 1918, at 10 A M (eleven and one-half hours after injury) Headache and nausea, condition good, no neurological symptoms

Wound circular, 1 cm in diameter, located 2.5 cm anterior to right tragus and 2 cm above zygoma X-ray—shrapnel ball in temporal lobe

Operation—June 12th, 2 P M (fifteen and one-half hours) Novocaine and adrenalin Entrance wound excised Flap of scalp and temporal muscle turned down to zygoma, uncovering extensive fracture of squamous portion of temporal bone Bone fragments removed, edges regulated One large and two small dural perforations Bleeding middle meningeal artery ligated with a clip Dural wounds connected, cavity 3 cm deep sucked and irrigated, metal and four bone fragments removed under finger control, dura sutured, gutta percha drain to dura through stab wound at upper margin of zygoma, entrance and operative wound closed in layers Shrapnel ball cultured—"Gram positive bacillus of Welch type and streptococcus"

Post-operative Course—June 14th—Sutures and drain removed June 23d—Wounds healed No discomforts Evacuated to Base

Later Reports—Letters from patient February 28, 1919 (eight months), "I am working under ground in the mines—sometimes I suffer with slight Headaches when I work too hard, otherwise I feel Champion" February, 1920 (twenty months)—Frequent headache and dizziness, but continues at work

Comment—This case was a revelation of the possibilities of local anaesthesia Turning down the entire temporal muscle in a heavily muscled man is a troublesome and bloody procedure under general anaesthesia, but with novocaine and adrenalin there was no bleeding except from a few large branches of the superficial and deep temporal arteries, and absolutely no pain The ominous bacteriology of the missile confirmed once more the absolute necessity of thorough removal of foreign bodies and damaged tissues

CASE XV—U/Off B S (prisoner of war) *Deep parietal cavity cleaned under finger control, motor loss slightly increased for twelve days after operation, rapid return thereafter Repatriated ten months later* Admitted June 18, 1918, at 4 P M (eight hours after injury) General condition good

Wound—Two cm in diameter, located 17/34 and 7 cm to right, brain tissue extruding X-ray—thin metallic fragment 1 by 1.5 cm and three or four medium-sized pieces of bone deep in parietal lobe (Fig 3)

Neurological—A left-handed individual Central type weakness of left face Left arm—motions at shoulder slightly subnormal, at elbow one-half normal, slight flexion and no extension of wrist and fingers Left leg normal Common sensation lost, roughly, below left elbow Astereognosis of hand, and loss of joint sensation of elbow, wrist and fingers on left Speech slightly slowed and blurred Exaggerated deep reflexes on left

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Operation—June 18th, 7 P M (eleven hours) Novocaine and adrenalin Triradiate incision, block of bone about defect excised Cavity cleaned by patient's efforts, suction and irrigation The 1 cm aperture in the dura, not wide enough to admit the index finger, was enlarged in its long axis The finger palpated an egg-shaped cavity 4 cm deep and about 2.5 cm wide in its greatest diameter Metal, seven bone fragments of medium size, and many smaller ones removed under finger control (Fig 4) Some bone spicules were so firmly embedded in the walls of the cavity that they were identified and freed with difficulty Dura sutured as far as possible, fascia and skin closed Duration of operation thirty minutes Metal and bone fragments cultured (no growth)

Post-operative Course—At end of operation there was no flexion of left fingers or wrist, elbow movements were slightly weaker than before, and the paraphasia was a little more marked June 20th—No aphasia or weakness of left face, arm as after operation Spinal puncture, 40 cc Sutures removed June 24th—Left arm improving, at shoulder and elbow same as before operation, at wrist very slight flexion and no extension July 1st—Left arm back to exactly same power as before operation July 11th—All motions left arm definitely stronger than before operation Identifies pin point above wrist July 16th—Left arm No demonstrable weakness at shoulder, slightly below normal at elbow, flexion of wrist and fingers one-half normal, extension one-quarter normal Sensory loss was the same as on July 11th Wound healed, no headache Evacuated to Base

Later Reports—From Medical Research Committee—admitted to hospital in England August 10th, discharged to Prisoners of War Camp September 12, 1918, repatriated April 10, 1919 No medical report obtainable

Comment—This was the only case in which routine examination immediately after operation showed any evidence of further brain injury attributable to the operative procedure The increased palsy was slight but definite, in twelve days it had come back to the condition that was present on admission, and in four weeks there was at least a 50 per cent improvement over motor power before operation It is impossible to tell, in a given case, whether the paralysis is entirely due to a destructive lesion of the motor cortex or path, or if not, what portion of it is due to concussion and oedema Certainly in this instance concussion, oedema, and hemorrhage into the brain cavity caused a considerable part of the palsy, and a part that was recoverable We feel that any trauma superadded by careful use of the finger is recoverable, and justified by the absolute insurance against brain sepsis which the procedure gives The case presents another point of interest Excellent stereoscopic radiographs showed only about half the medium-sized bone fragment recovered (Figs 3 and 4) It has been our experience that not more than 75 per cent of fragments with a diameter above 0.5 cm, and practically none

below that size, could be demonstrated radiographically. It would not seem wise to be content, if cleaning a cavity without finger control, with removing the number of fragments diagnosed by the X-ray. It is unfortunate that no further news of this man's physical condition after he was evacuated could be obtained. The fact that he was discharged from Hospital to P O W Camp three months after operation suggests that progress was satisfactory.

CASE XVI—Pte H P *Parietal cavity with hemiplegia. Metal and bone extracted from lateral ventricle under finger control. Residual hemiplegia nine months later.* Admitted June 12, 1918, at 6 A M (five and one-half hours after injury). Semi-conscious, rational when aroused, general condition fair.

Wound—One cm in diameter, located 18/32 and 10 cm to right X-ray—metal and bone in right cerebral hemisphere.

Neurological—Complete left hemiplegia, anaesthesia and spasticity of left arm and leg.

Operation—June 12th, 10 30 A M (ten hours). Novocaine and adrenalin. Triradiate incision, block of bone excised. During catheter cleaning of a track 7 cm deep blood-stained cerebrospinal fluid was aspirated. At full length of index finger the metal and a large bone fragment were extracted from the lateral ventricle, another large and many small pieces of bone were removed from the walls of the cavity (Fig 5). Scalp sutured, with gutta percha tissue wick to dura. Metal and bone cultured—"Gram positive bacillus of Welch type."

Post-operative Course—June 14th—Sutures and wick removed. Spinal puncture, 30 c c (no growth). June 16th—Wound rather tense, spinal puncture, 40 c c (no growth). June 24th—Motion returning in left face. Left arm and leg massaged daily. July 3d—Face improving slowly, arm and leg remain paralyzed and anaesthetic. Wound healed, no headache. Evacuated to Base.

Later Reports—March 6, 1919 (nine months), letter from patient's mother—"He is paralyzed in the left side but going on ever so well."

CASE XVII—Cpl A G S *Destruction of right occipital lobe involving ventricle, metal extracted under finger control through falx from left occipital lobe. Recovery with hemianopsia.* Admitted May 26, 1918, at 11 A M (twelve hours after injury). Semi-conscious, restless, fair general condition.

Wound—Two by 3 cm in diameter, located 28/34 5 and 7 5 cm to right, prolapsed brain. X-ray—metallic fragment in left occipital lobe, two bone fragments to right of midline.

Neurological—Blind, no pupillary reaction, spastic legs.

Operation—May 26th, 3 P M (sixteen hours). Novocaine and adrenalin. Triradiate incision, excision of block of bone about defect, exposing 2 cm hole in dura. After usual removal of pulped brain and clot, the finger palpated a large oval cavity into which the posterior horn of the ventricle opened. One piece of bone extracted from ventricle, and four others from the wall. The finger then detected

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a small hole in the falx cerebri. The external dural defect was enlarged to allow a catheter to pass in beside the finger, which guided it through the aperture in the falx where it grated on a foreign body (Fig 6). Forceps were introduced along the catheter into left hemisphere, the metallic fragment (a piece of helmet) was seized and extracted. Dura partly closed, scalp sutured with small gutta percha wick to dura. Metal and bone cultured (no growth).

Post-operative Course—May 27th—Very restless and irrational. Spinal puncture, 40 c c (no growth). May 28th—Alternate restlessness and drowsiness. Wick and sutures removed. June 4th—Headache, wound tense, spinal puncture, 45 c c. June 10th—Electric light flash detected. June 12th—Wound full, spinal puncture, 45 c c. Counts fingers in right visual fields. June 13th—Identifies by vision watch, pencil, etc. June 15th—On rough test, returning vision in right upper quadrants only. Pupils react to light. Wound healed, no headache. Evacuated to Base.

Later Reports—Notes from Discharge Documents, January 27, 1919 (kindness of Medical Research Committee). Visual acuity normal, left hemianopsia and lower altitudinal hemianopsia, difficulty in judging distance and position, frequent severe headaches, nervous apprehensive gait, spastic legs. January 4, 1920 (nineteen and one-half months), letter from patient. Periods of headache and dizziness, occasional attacks of petit mal. Walks cautiously with aid of stick because of limited visual fields. Apprehensive about skull defect and wants advice about cranioplasty.

Comment—This case brings out, better than any other, the advantages of the use of the finger. It is most unlikely that the bone fragment in the ventricle could have been detected and removed by any other method, and it is certain that, except by palpation, location of the hole in the falx and extraction through it of the metal would not have been possible.

The Fatal Cases—There were four post-operative deaths in Group B.

CASE XVIII—J. B. M. (aged French civilian). *Extensive destruction of cerebral hemisphere. Death in forty hours from brain injury.* Admitted June 5, 1918, at 9 A. M. Deeply comatose, pulse, 102, probable left hemiplegia.

Wound—Tangential, above right pinna, prolapsed brain. X-ray—fractured skull, no metal.

Operation—June 5th, 1 P. M. (interval unknown). Triradiate incision, block of bone including gutter defect excised, large parietal cavity cleaned of pulped brain, bone and hair, scalp closed.

Post-operative Course—June 7th—Died without regaining consciousness forty hours after operation. Wound clean. No autopsy.

Comment—With greater experience this case would have been passed as inoperable.

CASE XIX—Sec. Lieut. B. *Extensive destruction of both frontal lobes, fractures involving nasal sinuses. Death fourth day.* Admitted

June 5, 1918 (one-half hour after injury) Unconscious, pulse, 100, no paralysis

Wound—Extensive, 5 cm above outer canthus of left eye, brain extruding X-ray—large metallic fragment in right orbit

Operation—June 5th (five hours) Novocaine and adrenalin Triradiate incision, large bone defect with radiating fissures regulated, many bone fragments removed under finger control from extensive cavity in frontal lobes, scalp sutured

Post-operative Course—June 6th—Unconscious, incontinent June 7th—Wound clean, sutures removed Metal removed from right orbit under light ether anæsthesia (Captain Haycroft) June 8th—No return of consciousness, temperature, 100°, pulse, 120, rhythmic respirations Spinal puncture, 90 c c (no growth) June 9th—Died at 3 P M

Autopsy—Sutured wound clean Entire frontal bone shattered, fissures into both orbits, parietal bones, sphenoid bone, and cribriform plate of ethmoid Anterior poles of both frontal lobes destroyed, longitudinal sinus divided, no bone fragments except in right orbit No evidence of sepsis, no hemorrhage

Comment—This was apparently a delayed death from brain injury, though the possibility of acute streptococcus encephalitis cannot be ruled out in the absence of cultures of the brain at autopsy

CASE XX—L/Cpl W K *Metal lodged in posterior fossa after traversing left cerebrum, lateral ventricle and right cerebellum not removed Death ninth day from encephalitis and ventriculitis* Admitted May 13, 1918, at 10 A M Deeply unconscious, cold, with poor pulse of 100 After application of heat pulse came down to 86, fair quality

Wound—Circular, left parietal, extruding damaged brain X-ray—shrapnel ball in right posterior fossa

Neurological—Probable right hemiplegia, eyes deviated to left

Operation—May 13th, 2 P M (interval unknown) Novocaine and adrenalin Triradiate incision and block trephine Ten bone fragments removed from large parietal cavity and lateral ventricle under finger control Scalp sutured

Post-operative Course—May 16th—Appears to understand, motor aphasia and right hemiplegia, taking fluids Wound tense, spinal puncture, 40 c c May 18th—Temperature, 101°, pulse, 120 Disorganized brain (culture streptococcus and staphylococcus) oozing between sutures Wound opened May 20th—Less aphasic Small brain fungus Temperature 100°, pulse, 112 May 22d—Died after rapid rise of temperature to 104°, pulse to 160, and respiration to 42

Autopsy—Generalized meningitis, thin pus in ventricular system Track through left ventricle, corpus callosum, and right cerebellum, shrapnel ball resting on dura No bone fragments found in parietal cavity, ventricle, or cerebellum

Comment—This man died of sepsis and might have lived, in spite of the extensive brain damage, if the track could have been thoroughly cleaned The operation was insufficient, we should have trephined the

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right occipital bone and cleaned the cerebellar track. The result might have been the same, but everything possible would then have been done and the chances of sepsis would have been reduced.

CASE XXI—Sgt H N. *Bullet traversed both cerebral hemispheres and lodged near entrance wound. Death from hemorrhage same day.* Admitted May 30, 1918, at 7 A M. Condition poor, comatose, cold, respiration stertorous, pulse 100 and irregular. Resuscitation ward.

Wound—Small, circular, through left temporal muscle at upper margin of pinna. X-ray—rifle bullet in left hemisphere close to entrance wound, deeply indriven bone.

Neurological—Probable right hemiplegia. At 1 P M he was warm and pulse had improved, in view of the location of bullet operation was undertaken despite poor condition.

Operation—May 30th, 2 P M (interval unknown). Novocaine and adrenalin. Triradiate incision and removal of block of bone. Clot extruded under pressure, carrying out the bullet. Very free bleeding not controlled by hot irrigation. Finger palpated a large cavity involving lateral ventricle. Gauze tampon carried into ventricle, scalp sutured.

Post-operative Course—Died same day at 7 30 P M.

Autopsy—A large cavity in left parietal lobe containing clot and bone fragments, ventricle open, left choroid plexus apparently injured. Track continued through right parietal lobe to dura (Fig 7). Anterior cerebral artery divided. No bone in right hemisphere.

Comment—This is an example of the freakish things that the metallic fragment may do inside the cranium. Possibly the bullet rebounded from the right parietal bone along its track to midline, and was then carried toward the entrance wound by the hemorrhage.

CLASSIFICATION OF FATALITIES

To sum up the causes of death in the seven fatalities following operation there were

- 1 One death not attributable to the brain wound (Case VIII)
- 2 Two unavoidable deaths due to extensive brain injury (Cases XVIII and XIX)
- 3 One unavoidable death due to hemorrhage (Case XXI)
- 4 One unavoidable death due to sepsis in an incompletely cleaned cavity communicating with a nasal sinus (Case X)
- 5 One death from ventriculitis in which magnet extraction might have offered a chance (Case IX)
- 6 One death from sepsis which might possibly have been avoided by more complete operation (Case XX)

In addition, there was one septic brain fungus in Case XI, luckily not fatal, due to inefficient cleaning by the catheter technic, which would almost certainly have been avoided had finger palpation been used.

So far as is known, all of the thirteen evacuated cases are alive to-day, and their condition at last report is summed up in the following table

TABLE II
Tabulation of Late Results

Case	Last report	Head-ache	Dizziness	Epilepsy	Other neurological signs	Occupation
2	21 months	+	+	o	Paraphasia Paresis face Mental changes	Mill worker
3	11 months	+	o	o	Paresis, sensory loss arm	Working
4	20 months	+	+	o	o	o
5	6 months	Ambulatory, wounds healed				No further information
6	7 months	+	o	o	o	In hospital
7	20 months	+	+	o	Unilateral deafness	Working
11	20 months	o	+	Severe 12th month	o	o
12	20 months	o	o	o	o	Warehouseman
13	17½ months	+	o	Jacksonian 10th month	Paraphasia	Mine worker
14	20 months	+	+	o	o	Miner
15	10 months	Motor and sensory improvement 4 weeks, no medical report after Discharged hospital 3d month, repatriated 10th month				
16	9 months	?	?	o	Hemiplegia	o
17	19½ months	+	+	Petit mal	Hemianopsia	o

SUMMARY Normal
 Subnormal
 Pathological
 Insufficient data

Cases 12, 14 = 2
Cases 2, 3, 4, 6, 7 = 5
Cases 11, 13, 16, 17 = 4
Cases 5, 15 = 2

13

Only two can be classed as normal individuals from the information at hand, both were working and had no discomforts of any moment, though one had a blind eye. Three of the subnormals were working and apparently not much handicapped. Only one of the pathological cases (XIII) was working, in spite of epilepsy, while the other three can never be self-supporting. The two cases unclassified because of lack of information would, at a guess, be normal (Case V) and pathological (Case XV).

REVIEW OF LITERATURE

Pathology—The existence of a cavity rather than a narrow track has been noted by many observers. Latarjet²⁴ says that the dural lesions are always less extensive than the brain lesions. Sencert²³ has seen brain cavities that would hold an egg progress to cure, and says that brain lesions become larger by the pressure of hemorrhage on the walls of the friable brain tissue. Schwartz and Mocquot,³² speaking of metallic fragments lodged in the brain say, "There exists in these cases not only a track followed by these projectiles, but an actual *destructive cavity*." Archibald⁴ puts it, "The area of destruction of brain substance is decidedly wider than the actual track of the projectile."

Methods of Cleaning Brain Cavity—Among many different procedures that have been used separately or in combination, there are five which have numerous advocates. Finger palpation, curettage, catheter and forceps, extraction with magnet, and forceps extraction under visual control (radioscopic screen).

Extraction with the magnet or under the screen are recognized as methods of value in recovering small and deeply placed metallic fragments. They require equipment which is not always available, and as they do not remove all the bone fragments and other foreign matter they must be combined with some other procedure if the track is to be properly cleaned. Rouvillois³⁰ claims for extraction under the screen that clot, damaged brain, and bone fragments precede the metal, he extracted thus 47 metallic fragments with 18 cures and 29 fatalities, but he does not give the incidence of encephalitis. One would suspect that the method could not be relied on to remove all bone fragments.

Curettage of the cavity in the brain has advocates whose results speak strongly for the method. Ehrenpreis¹⁴ uses a small silver spoon with which he extracts very slowly and gently foreign bodies 6 or 7 cm deep, he says that one recognizes without difficulty the difference in consistency between damaged and healthy brain. Henrard and Janssen²⁰ report four cured cases in which metallic fragments (one at level of the sella and 2 cm behind the posterior clinoid processes) were extracted with the magnet. They curetted the track and closed the scalp temporarily over a tampon in the brain cavity. Tanton³⁶ curettes gently until white matter without clot begins to appear. Willems and Albert,⁴⁰ whose latest results (Willems³⁹) are the best we have found in the literature, use the curette. Albert,² reporting the same series of cases in more detail, gives the technic as follows: Widen dural opening if necessary, remove bone fragments with a Kocher clamp, curette damaged brain and bone dust from the walls of the cavity and remove metallic fragment with magnet. Chauvin⁸ says the walls of the curetted cavity ooze rather abundantly and persistently, and in this connection it is interesting to note that Henrard and Janssen tampon the cavity temporarily and do a secondary closure, and that Willems and Albert say that they tampon the cavity only when hemorrhage cannot be stopped by other means. There is a suggestion here that curettage may cause troublesome bleeding.

Catheter palpation with forceps extraction of metal and bone or with magnet extraction of the metal, as introduced by Cushing,¹⁰ has been used by Ney,²⁹ Horrax,²¹ Newton and Brown,²⁸ and Cutler,¹¹ all of whom found it satisfactory, and by Jefferson,²² who says "The evidence that was obtained from the catheter was unreliable. It is so important to make sure that all indriven bone fragments have been removed, that the introduction of a finger into the brain wound can hardly be avoided." Newton and Brown say "The practice of searching for bone fragments in the brain with the finger is one to be strongly condemned. Even when performed with great care it must result in increased damage to the brain."

In several cases in this series, one to one and a half hours were spent in the patient removal of fragments. That this painstaking cleansing by the catheter and forceps technic was not always complete is shown by their Case XVIII, in which autopsy showed unremoved bone fragments in a frontal lobe cavity. Horrax, using Cushing's technic, also

had failures, thus in Case XVII autopsy revealed bone fragments in an occipital lobe cavity, in Case XXIII there were unremoved bone fragments in a cerebellar cavity, and in Case XXIX a very large metallic fragment 2 inches from the dura was not detected at the first operation. Ney does not give case reports, but acknowledges that in wounds involving the ventricles the catheter tended to slide by the bone fragments in pockets of the walls of the cavity and enter the ventricle, "so it was mostly in these cases that the operation was not complete, in that some bone fragments would often be overlooked." Finally, in Cushing's⁹ report there are examples of encephalitis attributable to incomplete removal of foreign bodies by the catheter technic, as in Cases LVI, LXIV and LXXIV. In mentioning these unsuccessful cases of the adherents of the catheter-forceps technic we have selected those instances in which it seems, as far as can be told from the details given, as though the finger technic might have been successfully applied.

Finger Palpation—The literature indicates that by far the greater number of surgeons who have treated brain wounds advise this method, either alone or in combination with the magnet, curette or radiosopic screen. A few quotations from its stronger supporters will suffice. Leroy²⁶ says "Digital exploration is indispensable for detecting the presence of bone fragments." Mathieu²⁷ says "To detect bone fragments I do not hesitate to palpate the area of cerebral contusion with a gloved finger. It is a manoeuvre that, better than any other, permits one to avoid overlooking a small fragment. In passing thus, exactly through the track, the surgeon is sure not to augment the injury to the nervous tissue, he remains in the contused zone always more extensive than the track itself. If there exist nervous symptoms from the anatomical lesion, he cannot hope to make them improve, it is true, but he does not augment them." Sencert²⁸ says "When the cavity appears well cleaned and empty, I never fail to do a careful revision with the finger which discovers almost always one or more small bone fragments." Velter²⁸ says "The intracerebral exploration should be made *with the finger*, the index, rather than the little finger, is introduced gently into the cavity, thus one easily detects the smallest bone fragments, and even if the finger is not in immediate contact with them, it perceives a special resistance which does not deceive an experienced observer, the metallic fragments are also easily found." Gray¹⁶ says "Only very rarely is further injury to the brain caused by this procedure." Others use the finger, but rather apologetically, thus Jefferson says it "can hardly be avoided," and Lemaitre²⁵ says "Digital exploration should be feared because it is blind, but the finger detects foreign bodies deeply lodged in the cerebral tissue which a well guided forceps may thus seize." Among many others who practice finger palpation without any remarks on its advantages or disadvantages may be mentioned Abadie,¹ Bastianelli,⁶ Burckhardt and Landois,⁷ Delore and Arnaud,¹² Foisy,¹⁵ Kaerger,²³ Sargent and Holmes,³¹ and Schwartz and Mocquot.³²

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RESULTS

A study of the available reports shows that there are very few series of cases that can fairly be compared to ours. One must eliminate first of all those in which the scalp was not consistently closed, for they give no index of the value of the various methods of track cleaning. Secondly, cases not operated in forward hospitals during the first twenty-four hours after injury are of no use for comparison, for it has been shown that, paradoxical as it may seem, the cases done late at the Base frequently have a lower mortality rate than those operated in forward hospitals. The explanation is that the more serious brain injuries, as well as the less serious injuries with a fulminating infectious process, are eliminated by death and do not reach the Base hospitals, while in forward hospitals many of these less favorable cases are saved but more die, and mortality statistics necessarily rise in giving such risks a chance for life.

Taking only those series in which the scalp was closed after an early operation, one finds that there are still numerous sources of error. A forward hospital may take only "non-transportable" or the most seriously wounded, in which event a certain number of favorable brain wounds going back as walking cases are lost to its statistics. These favorable cases are often evacuated to the rear without operation, even if a forward hospital receives all head wounds from a given front. On the other hand, the mortality rates of an Evacuation Hospital which is well forward may be lowered because a Surgical Ambulance or a Mobile Hospital is working even further toward the lines and taking the most serious head cases. The question of judgment as to what are operable cases also plays a part, though it is noticeable that the tendency is to operate every head case that appears to offer the slightest hope of recovery unless, in so doing, the surgeon would jeopardize the chances of less seriously wounded men. Moreover, it makes a great difference whether the surgeon accepts all cases in rotation or selects his patients for operation. And finally, it is essential to know the late result, for a certain number of cases that appear to be cured when evacuated after ten to fourteen days do sometimes flare up with late abscess if all foreign bodies were not removed from the brain.

Of course, all these conditions for proper statistics cannot be met. But a good deal of interesting information can be drawn from the figures published. Taking the reports on brain wounds over which the scalp was not closed, we find that the early operative mortality is usually above 50 per cent, and that this is not the whole story is shown by the figures of Sencert and Sieur³⁴. They had an early mortality of 51.3 per cent, but on following up the evacuated, they found that, of 71 cases traced for over eleven months, 24 (presumably mostly brain wounds) had died. We have found only one series giving figures below 50 per cent—that of Derache,¹³ who operated 53 brain wounds, 15 of which died early, and 7 more in the following eight months, giving a mortality of 41.5 per cent. Several writers

give figures comparing their results before and after they adopted scalp closure. Gross and Houdard^{17, 18} in 107 unsutured cases had an early operative mortality of 56 per cent, while in a later series in which the scalp was sutured sixty-three times in 124 cases, their mortality was 38.7 per cent. Barány's⁵ figures are striking though incomplete. Without suture he lost 31 out of 39 brain wounds (79.5 per cent). In his next 21 cases he closed the scalp unless the brain wound was complicated by eye or nasal sinus injuries, of 14 closed scalps only 4 died, and the mortality of the remaining 7 which were left open is not given.

Velter³⁷ gives a complete report of 27 cases operated in a forward hospital in 1915-1916. This series is apparently exactly comparable to ours except that his cases, although received early, were not always promptly operated. He used finger palpation and closed the wounds. The operative mortality is given as 33.3 per cent. Analysis of the cases shows, however, that he does not use quite the same classification of brain wounds, and that a revision of his statistics and inclusion of the late deaths would give a mortality in the vicinity of 50 per cent. Kaerger²³ reports 86 cases operated in a Feldlazarett with a mortality of 43 per cent. He used finger palpation and closed the wound. Cushing's⁹ mortality in 133 cases was 41.35 per cent. Willems³⁰ had a 26.1 per cent mortality in 46 operated cases. Among these were at least 11 cases in which an intact dura was opened and closed at operation, such a large proportion of this comparatively favorable type of brain wound may account to some extent for the very low figure. Cutler¹¹ operated 25 brain wounds with 6 deaths (24 per cent), but "non-transportable" hospitals were working ahead of him, and some of his cases were under observation little over a week after operation.

The more one studies reports on brain wounds the more he is impressed with the fact that the figures are usually of little real value, and that the true criterion is whether fatal cases might have been saved by other methods. Unfortunately, very few reports give sufficient detail to form a basis for such judgment. If all series had been given in the same detail as Cushing's, for example, there would be an opportunity to form a much clearer opinion on the comparative values of the different methods of treatment.

THE ROUTINE TREATMENT

On notification of the admission of a head case, one of the members of the team saw him in the receiving ward as quickly as possible, made a rapid estimate of his general condition and neurological symptoms, and ordered him sent to the resuscitation ward, X-ray, or directly to the operating room. Unless obviously a subject for general anaesthesia the patient was given hot drinks. As soon as one of the team's two operating tables was free, $\frac{1}{4}$ grain of morphia was administered if indicated, and the head was completely shaved and cleaned with soap, alcohol, and bichloride of mercury 1/1000. One member of the team dropped out of the operation in progress five or ten minutes before its completion and anæ-

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thetized the scalp of the next case. When general anæsthesia was required, novocaine and adrenalin were also used for hæmostasis. The operation proceeded in the following steps

1 The damaged scalp and pericranium was excised, with fresh instruments the wound was extended in three directions, or a flap was turned down if the temporal or occipital muscles were involved. The dry wound was treated with tincture of iodine, and fresh towels or gauze were clamped over the reflected flaps leaving in the field only the area of fractured skull.

2 Usually a block of bone including the defect was excised by connecting several burr holes with a Montanovesi cutting forceps. Sometimes an extensive punched-out defect was merely enlarged with rongeur forceps. In any case less than 10 cm of intact dura was exposed about the dural opening. Bone wax was used for hæmostasis.

3 The patient now coughed and strained. Pulped brain and clot which extruded immediately after removal of the bone block and at this stage were carefully removed with gauze sponges.

4 A 17 F soft rubber catheter with an attached syringe removed all soft débris from the cavity by suction, beginning under the dura and progressing to the deepest portion. Then a few c.c. of hot normal saline solution were introduced and sucked out repeatedly until the solution returned clear.

5 A If the information derived from X-ray, inspection, and catheter palpation indicated that the track in the brain was too small to permit introduction of a finger, the metal and bone fragments were removed as thoroughly as possible with delicate duck-billed forceps passed down the palpating catheter (Cushing's technic).

B If the defect in the dura was large enough, a finger was introduced very gently and each foreign body when palpated was seized and removed with the forceps.

C If the defect in the dura was too small to admit a finger, while all information pointed to a cavity in the brain large enough for finger exploration, the dura was incised to allow the finger to enter. When the cavity was clean it was again irrigated and sucked dry until hæmostasis was satisfactory. Bleeding pial or dural vessels were ligated with Cushing's silver clips.

6 The dura was sutured partially, or, if possible, completely, with fine chromicized catgut or silk.

7 The extra-dural wound was washed with ether and painted with tincture of iodine.

8 The scalp was closed with a few plain catgut stitches in the galea at the junction of the flaps, and with silkworm gut in the skin. A small gutta serena tissue wick was introduced to the bone if hæmostasis was doubtful.

Immediately after operation, if it was under local anæsthesia, the neurological findings were checked up. The patient was put up on a

back rest or high pillows The wound was inspected daily, if it showed any tension or if headache was complained of a spinal puncture was done and repeated as often as indicated Sutures and wick were usually removed in twenty-four or forty-eight hours

After a review of the literature we would be inclined to modify this technic in one particular When the track is too small for the finger, and the foreign bodies are not more than 6 or 7 cm deep, it seems probable that a small flexible silver spoon would prove more satisfactory than the catheter and forceps If a portable magnet were available, it would undoubtedly be of occasional service

GENERAL CONSIDERATIONS

Throughout the war there was a tendency in some quarters to look on brain wounds as rather hopeless propositions, to be passed on to hospitals in the rear, or to be treated in "head centres" nearer the front The feeling was that these casualties needed very specialized and expert care One British army tried the concentration of head cases in a group of Clearing Stations in 1917, and the same idea was put into effect on a smaller scale in the American First Army in 1918 We happened to be able to observe part of each of these experiments, and received a strong impression that this was not the best way to deal with brain wounds, for it resulted in confusion in evacuation, decrease in ambulance efficiency, prolongation of the pre-operative interval, and early filling of beds with non-evacuatable cases

All of these disadvantages were avoidable by allowing each forward hospital to take care of brain wounds just as they came with the other casualties, and this was usually done with satisfactory results Up to the publication of the catheter-forceps technic with its condemnation of finger exploration, it had been generally felt that a surgeon who was fitted to do major work in forward hospitals was capable of doing brain wounds, and the results had been quite good in spite of the inadequacy of the tools that were usually available Cushing's paper was undoubtedly a blow to much of this work A surgeon who had been rapidly cleaning brain cavities under finger control was now faced with the alternative of devoting "upward of two hours" to a case, or passing it on to the Base, unless he was willing to back his own experience and use his old methods Those who have followed the Cushing technic have emphasized a fact that is very true—that it does require a great deal of experience, as well as a great deal of time Cutler¹¹ says "Unless a surgeon thoroughly familiar with this field of surgery is available in the most forward areas, it would seem to us advisable to transport such cases further back where men trained in this field may be found This may mean the necessity of very long transportation before operation Even so, we think it would be safer than operation by untrained hands" Here we have the logical development of the tendency to make operations for brain wounds specialized and expert work, if a man trained in the catheter-

forceps technic is not at hand, the case must undergo the risk of infection and travel back to such a man. This is against all the lessons of the war, which have brought out, above all else, the absolute necessity of providing the severely wounded with early and complete operation as the only safeguard against sepsis.

Operations on brain wounds do not deserve the reputation of being prolonged and difficult, or of requiring great experience. They are, as a matter of fact, quite easy provided one has the proper tools and knows how to use them. Abdominal wounds do best in the hands of a surgeon who has done much abdominal work. Excision of all the damaged tissues in a compound fracture of the femur so that the wound stays clean and can be secondarily sutured is an operation requiring a large amount of skill, patience, and experience. By comparison, a brain wound, especially if it can be quickly cleaned under finger control, is a very simple procedure. The type of surgeon who must handle most of the operating in forward areas—that is, the younger man, recently out of hospital—adapts himself rapidly to the unaccustomed work. We have seen surgeons with little or no previous experience in cranial work get excellent results immediately they had learned the few simple technical tricks of infiltrating the scalp, controlling hemorrhage from bone, dura or brain, using the palpating finger properly, and doing a plastic closure. But if one feels impelled to blindly clean a brain cavity without the aid of the finger, it is an entirely different story, for then a large amount of practice in the delicate technic of detecting fragments with the catheter and grasping them without injuring the adjacent healthy tissues is absolutely necessary. Nor, in our experience, does previous familiarity with civilian intracranial surgery prove of much help in this procedure. One of us had been trained in neurological surgery, but was quite unable to use the catheter technic satisfactorily, the other, with no previous experience, found that cleaning by the finger technic was an astonishingly rapid and easy operation.

SUMMARY AND CONCLUSIONS

An unselected series of 28 brain wounds in a forward hospital was treated with the conception that the problem involved was the absolutely complete removal of contaminated damaged brain, blood-clot, hair, cloth, bone and metal, so that primary suture might result in clean healing. The method adopted was to suck and irrigate out the brain and clot, and then extract with fine forceps bone and metallic fragments detected by a gentle palpating finger, provided the cavity was sufficiently large to admit the finger. The size of the hole in the dura was not taken as an index, but was enlarged if necessary. In some cases this finger technic, always (with one exception) preferred if possible, was contraindicated by the small size of the track in brain substance, or by the awkward situation of wounds caused by missiles passing in via the deep nasal sinuses, in these instances cleaning was done as well as possible with catheter and forceps.

Of the 28 cases 8 were considered inoperable and died without intervention in a few hours, 20 were operated, and of these 7 died, giving a mortality of 35 per cent. More important than the mortality figure is a study of the cause of death in these 7 cases, which shows 1 death from empyema with healing brain wound, 3 unavoidable deaths due to extensive brain injury or arterial hemorrhage, 1 unavoidable death due to sepsis, in which a deep cavity communicating with a nasal sinus could not be reached for proper cleaning, 1 death from streptococcus ventriculitis caused by a deep-lying minute metallic fragment which could probably not have been extracted even with a magnet, and 1 septic death from a wound involving cerebrum, lateral ventricle, and cerebellum in a case that should have been given the benefit of more extensive operation with removal of the metal through a counter opening. In short, there was no death from encephalitis when the metal and bone were within reach in a cavity large enough to admit the finger, and only two of the seven deaths could possibly have been avoided by the use of the magnet or by more extensive operative procedures.

A study of the 13 evacuated cases shows that 12 healed by first intention, and that the other developed a septic brain fungus, which was not fatal, after a prolonged attempt to clean a cavity by the catheter-forceps technic. In only one instance did routine post-operative examination show a slight and temporary increase in the signs of brain injury. Several cases are reported in which it seems highly improbable that the foreign bodies could have been removed without finger palpation. Later results in the 13 evacuated cases for periods of from six to twenty-one months after operation show that there were no late abscesses, that six patients were working, that major epilepsy developed twice, and that two only can be considered as not distinctly subnormal.

From these facts and from a study of the literature we would draw the following conclusions:

- 1 Entry of a foreign body into brain tissue causes irreparable damage to a more extensive area than that involved in the actual track of the foreign body, and this cavity is further broadened by hemorrhage, hence the size of the metallic fragment or of the dural aperture is not a true index to the wider area of damage represented by the brain cavity.

- 2 When such a cavity is not over 7 cm. deep and large enough to admit a finger, cleaning with forceps under careful finger control gives absolute insurance against sepsis, and only very rarely causes increased cerebral trauma which is slight and recoverable.

- 3 Cleaning of such a cavity by Cushing's method of catheter palpation is sometimes not complete and therefore does not always prevent sepsis, it necessitates a prolonged operation, and it is successful only in the hands of those who have had a large experience in its technic.

- 4 Brain wounds not suitable for finger palpation must be cleaned as well as possible by the catheter method, curettage, or magnet extraction, or a combination of these methods.

- 5 The tendency of the difficult catheter technic to make this a special

field, which requires that the wounded undergo delay if a trained neurological surgeon is not at hand, is not for the best interests of the patient, who is put under increasing risk of encephalitis with every pre-operative hour

6 Brain wounds, and especially those suitable for finger palpation, are easy to clean rapidly and successfully if a few proper instruments are available. Any surgeon fitted to do front-line work can quickly acquire the technic and do these cases in well under an hour, and, with experience in judging which casualties are inoperable, may well succeed in evacuating 75 per cent or more of his operated cases

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CRANIO-CEREBRAL WOUNDS DUE TO PROJECTILES *

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THERE were approximately 80 wounds in patients admitted to Base Hospital 61 diagnosed as head injuries. Of these, 60 involved the cranium and 20 the brain. Head injuries comprised about 5 per cent of all our gunshot wounds. Unfortunately, accurate records of all our cases are not available. Record keeping was reduced to a minimum, and during rush periods these were very meagre indeed.

We have studied 40 cases of gunshot wounds involving the head. Eighteen were scalp wounds, and 22 were cranio-cerebral.

Of the scalp wounds little need be said except to emphasize that the greatest care should be taken in the diagnosis of these less serious lesions. It is best to explore these wounds when time will permit even in the presence of the negative routine X-ray finding.

In the cranio-cerebral group there were 22 gunshot fractures of the skull. From the clinical standpoint there were seven fractures involving the frontal bone, one the frontal and temporal, five the temporal alone, two the occipital, one the parietal alone, and one the temporal and parietal. In five the lines of fracture were not stated.

It is emphasized that the head injuries which were received at this Base were cases which had already received treatment at the front. They were post-operative cases or those in which operation had been deferred.

The question of what to do with retained intra-cranial foreign bodies presents an interesting phase of the subject. The following cases open this topic for discussion.

The first case was received in the first "convoy." He was admitted apparently *in extremis* and demonstrated the wonderful vitality which our soldiers have frequently shown. His case presented the following outstanding features: Gunshot wound of the temporo-parietal region, compound fracture of the skull, retained shell fragment, bacteræmia. Death. At autopsy, in addition, metastatic pulmonary abscesses.

Private W S, aged twenty-two years, No 2428567, Co I, 325th Infantry, was wounded October 15, 1918. The following day a foreign body was localized by the X-ray, and a piece of bone removed. He was admitted to Base Hospital 61 October 27. Pus oozed from line of fracture. His condition was so poor that he was immediately placed on the critically-ill list. There was a smart hemorrhage from the scalp wound. The temporal artery was ligated in the ward.

Neurological examination by Lieut Col Somerville showed

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pupils were equal and reacted to light. There was weakness of both external recti. No optic neuritis. Disks clear but veins enlarged. No nystagmus. Tongue protruded straight. There was no disturbance of sensation. There was motor paralysis of both arms and lower extremities, not complete in right lower extremity and more marked on the right than on the left and in the muscles of the shoulder girdle. No astereognosis. All tendon reflexes exaggerated. Babinski, Oppenheim, and Chaddock signs positive right and left sides. Hoffman's sign was positive right and left. Slight spasticity of extremities. Abdominal reflexes absent. Cremasteric right slight, left absent. No aphasia. Slight hesitation and mental dullness.

The clinical symptoms indicated a lesion in both hemispheres due to abscess of the brain. After consultation the condition of the patient was considered too bad for operative interference. The patient died November 17, 1918.

At autopsy the subject was emaciated, general nutrition poor. Decubitus ulcers were found over sacral and scapula regions. There was a wound in the right temporo-parietal region. Both pupils were dilated, the left more than the right.

There was a suppurating wound located over the right temporo-parietal region. On the removal of the scalp, pus was found over the parietal and occipital regions. Upon the removal of the calvarium the meninges were found to be covered with pus, especially the left and right parietal regions. The exudate covered the pia along practically all the large vessels. There was an escape of much sero-purulent fluid from the spinal canal. The brain was sectioned horizontally just above the level of the corpus callosum. The missile had entered the skull in the right temporo-parietal region, traversed the right hemisphere, and was lodged in the left hemisphere just above the left lateral ventricle. The cavity surrounding the missile was 5 cm long, 2 cm wide, and 2 cm deep. It was filled with thick yellow pus. The shell fragment was irregular in shape and measured 1 cm long, 5 cm wide, and 5 cm thick (Fig 1).

The left lung was firmly adherent at the apex. A few areas contained pus (metastatic abscesses). There were also metastatic abscesses in the lower margins of the left lobe surrounded by areas of consolidation.

The heart was normal. A few yellow plaques were found on the aorta at the ascending part of the arch and along the openings of the intercostal vessels.

The genito-urinary system, liver, spleen, thyroid, adrenals, and bones were normal.

Bacteriology Heart's blood showed staphylococcus. A smear taken from the abscess of the brain showed streptococcus and many Gram-positive diplococci.

A second case of retained shell fragment shows the remarkable tolerance at times on the part of the brain to foreign bodies. The patient had meningeal symptoms which subsided following operation with recovery.

Corporal V H , aged twenty-six years, Co C, 30th Infantry, was first treated October 12, 1918, by Ambulance Co No 7 He was then removed to an evacuation hospital where X-ray revealed the presence of a foreign body in the occipital region of the brain He was admitted to Base Hospital 61 October 15, 1918, and was in excellent condition Eye grounds showed double choked disk, more marked on right Later the left showed more swelling Examination of spinal fluid showed a cell count of 160 per cm There was rigidity of the neck for several days The signs of meningitis disappeared and the patient began to improve The bilateral choked disk persisted Pupils normal External ocular muscles normal No paralysis of the face or extremities Left-sided hemianopsia then developed The abdominal reflexes were present and equal There was no Babinski The focal symptoms indicated a lesion in the right occipital region

The temperature ranged from normal to 102.2 from October 15 to October 26, the pulse from 60 to 88, thereafter within normal limits The foreign body was localized by the X-ray Stereoscopic plates were taken

On November 8, an exploration of the brain was made, but the foreign body was not recovered The patient reacted well The following day retinal hemorrhages were observed on and near the disk in both eyes Choked disks were less marked on November 25 This patient was discharged and returned to the United States as a class "D" patient

A case of shrapnel ball retained within the skull is of interest The ball entered the right eye and fractured the orbital fossa Private J B , aged twenty-four years, Co H, 23d Infantry, was wounded November 3 and admitted to Mobile Hospital No 2 There a débridement of the wound of the scalp was done Primary suture The right eye was enucleated He passed through Evacuation Hospital 10 where no entry was made on the field medical card There was no record of any X-ray having been taken The patient was admitted to Base Hospital 61 November 7, 1918 There was a contused wound of the left shoulder and scalp wound of the right parietal region The right eye had been removed Examination of the left eye showed mild catarrhal conjunctivitis, congestion of the head of the optic nerve and surrounding area, indicating a beginning neuroretinitis He later developed a left-sided hemianopsia No paralysis of face, arms, or legs

He was X-rayed and we were somewhat surprised to learn of the presence of the foreign body Convalescence was uneventful and he was returned to the United States

Hernia of the brain may occur as a complication after the acute developments incident to gunshot fractures of the skull have subsided We encountered one such case in a compound fracture of the frontal bone, also with retention of shell fragments



FIG 1—Private W. S. Lateral view of the skull. Shows foreign body

FIG 2—Same case. The white arrow points to the abscess cavity in the brain. The black arrow points to the foreign body

FIG 3—Lateral view of the skull Corp V. H. The white spot in the occipital region is the foreign body



FIG 4—Private J. B. The white spot indicates a shrapnel ball

FIG 5—Private L. A. Shows opening in the frontal bone, the seat of a compound fracture of the skull. The double subtemporal decompression and the foreign body are also shown. The white shadow indicates the latter. The shadows of decompressions overlap and lie above and in front of the shell fragment

FIG 6—Pvt M. P. age 25 309 Inf—Compound fracture of the frontal bone. Trephine opening in the skull above the safety pin (X-Ray taken with bandage on)



FIG 7—Pvt A. B.—Compound depressed fracture of the frontal bone. Shows opening in the skull

FIG 8—Pvt R. J. R.—Compound fracture of the frontal bone. Note trephine opening and foreign body

FIG 9—The same case lateral view

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Private L A, Co C, 320th Field Artillery, was admitted to Mobile Hospital 6 on October 18, 1918, from Field Hospital 328, in coma and much shock. The frontal bone had been fractured in the midline about 5 cm above the nose. At operation the brain and dura were found injured. Spicules of bone had been driven into the frontal lobes of the brain. Three pieces were removed from a depth of 5 cm and the wound was débrided. Neither dura nor scalp was completely closed.

Upon arrival at Base Hospital 61 eight days later, there was a fungous mass protruding through the skull a distance of $1\frac{1}{2}$ cm. There was a loss of tissue about 2 cm in diameter in the right frontal bone. There was a healed semilunar incision in this region 2 cm above the right eyebrow. Marked aphasia and a partial right hemiplegia were present. The latter was more marked in the face and arms. The pupils were dilated and equal. Both eyes showed optic neuritis, left 4D and right 2D. Babinski sign was positive on the right side. Examination of eye grounds November 8, showed double choked disk, more marked on the left. Retinal hemorrhages on the left. A bilateral subtemporal decompression was performed on November 12. The hernia was removed and a celluloid plate was inserted into the defect. The skin was brought together under some tension. Improvement in aphasia and hemiplegia was progressive. The wound healed by primary union, leaving a small defect where the skin edges had separated. On November 19, the choking of the disks was less marked in both fundi, and on December 10, a sliding flap was made to cover the small defect in the skin of the forehead. This patient was returned to the United States. Upon discharge the wound was healed and the patient was in excellent condition.

Exophthalmos is an infrequent complication of fractures of the base. This was noticed in a compound depressed fracture of the mastoid portion of the temporal bone attended with an escape of brain tissue. The gunshot wound appeared below the right ear. There was no retention of the missile.

Private A R, Co F, 61st Infantry, was admitted to Evacuation Hospital 6 October 17, 1918, where his wound was debrided and depressed fragments of bone removed. The patient was in shock and showed some rigidity of the neck. There developed marked exophthalmos of the right eye. Brain tissue and spinal fluid were discharged from the external auditory meatus. When brought to Base Hospital 61 on October 24, seven days later, he was in much pain. There was rigidity of the neck, a marked exophthalmos, and a discharge of cerebrospinal fluid from the right ear. On November 3, under treatment, much improvement was noted. Exophthalmos diminished, but there was persistent rigidity of the neck. No paralysis of face or extremities. The knee-jerks were both very active, left more than right. Left ankle clonus present, no Babinski. Patient continued to improve. On December 9, complete atrophy of

the right optic nerve was recorded, no vision The patient was returned to the United States

Aphasia is commonly seen in civil practice, and has been commonly encountered by us in war fractures of the skull

Private A B, Co M, 77th Division, aged twenty-five years, sustained multiple gunshot wounds He passed through Field Hospital 238 where he was dressed, and Evacuation Hospital 14 on October 15, 1918, where a compound depressed fracture of the frontal bone was diagnosed At the operation, the depressed fragments of bone and two small foreign bodies were removed

Upon admission to Base Hospital 61 October 26, 1918, a wound in the frontal region showed a free discharge of pus There was no pathological condition of the fundi noted The patient stated that following the injury he could not talk, but he knew what he wished to say (motor aphasia) On November 2, he showed no symptoms of aphasia There was a slight weakness in the lower muscles of the right side of the face The patient soon recovered sufficiently to be returned to the United States

Infection, focal symptoms, and hernia of the brain do not necessarily follow a compound fracture of the skull even in those cases in which a foreign body remains imbedded in the brain The following case showed a smooth rapid recovery, almost without interest

Private R J R, Co G, 26th Infantry, was wounded October 4, 1918 He was admitted to a mobile hospital the same day with a depressed fracture of the frontal region of the skull The scalp wound was excised, the opening in the skull enlarged and depressed fragments removed No foreign body was found The dura was closed He was subsequently admitted to Base Hospital 61 October 9, 1918 The wound was found clean and the sutures were removed The X-ray demonstrated the opening in the frontal region and a small foreign body Lateral view shows a foreign body 1 by $\frac{1}{2}$ cm in the temporal region He was finally discharged and returned to the United States

The writer wishes to make, in addition, the following points

1 The incidence of various lesions encountered under "head injuries in battle casualties" 2 The mortality of cranio-cerebral wounds 3 Surgical treatment of these lesions

In Cushing's series of compound fractures of the skull he noted a mortality of 9 per cent in those cases in which there was contusion of the brain, with or without depression of the skull and with intact dura Depressed fractures with punctured dura he usually found attended with neurologic symptoms The mortality was 11 per cent In those cases presenting severe cerebral contusion due to in-driven fragments of bone occasionally showing extrusion of the brain, fungus, or encephalitis, the mortality was 24 per cent In the penetrating cerebral wounds with

marked contusion along the tract, with lodgment of the projectile and bone fragments, at times hernia of the brain, lesions which frequently lead to early compression or late abscess, he found the mortality was 36.5 per cent. Penetrating wounds of the ventricles attended with hemorrhage and infection of these structures are the most serious wounds which may be encountered. Penetration may be due either to bone fragments or projectile. If due to projectiles the mortality is 100 per cent, if due to bone fragments, 43.5 per cent. In another series with involvement of the orbital, nasal, and auroretrosal areas, meningitis is frequent and the mortality 73.3 per cent. In the case of through-and-through cranial wounds the mortality is 80 per cent. In wounds with massive comminution of the skull the mortality is 50 per cent.

During the late war a serious effort has been made to reduce the commonly accepted mortality of 50 per cent for cases of compound fractures of the skull as seen in civil life. In this Cushing has been successful through the development of a standardized procedure and technic. Thus, in his first series of 44 cases, the mortality for the whole was 54.5 per cent. In a second series of a like number of cases he reduced the mortality to 40.9 per cent, and in a third series of cases to 28.8 per cent.

The improvement in mortality in no wise indicates that in the third series of cases were the lesions selected or of a less serious nature. On the contrary, more unpromising injuries were treated as technic developed.

Cushing's routine pre-operative features consist of preliminary neurologic study of all cases, stereoscopic X-ray negatives, shaving of the entire scalp, and the use of local anæsthesia. All serious cases should be dressed in the operating room rather than in wards—no doubt all these factors contribute to a successful outcome in serious cases.

The main features of Cushing's procedure are as follows:

- 1 The removal *en bloc* of the area of cranial penetration
- 2 In the detection of in-driven fragments of bone by means of rubber catheter palpation rather than by digital or other instrumental exploration
- 3 In the suction method of removal of disorganized brain tissue, the retention of which pulped or devitalized tissue in the tract favors infection
- 4 Cushing considers dichloramine-T particularly suitable for infection in brain tissue

Cushing gives preference to the radial or tripod incisions and believes in the closure of wounds.

In the matter of primary wound closure, considerable discussion has been evoked. Thus, Moulouguet and Legrain emphatically declare it to be dangerous, maintaining that a wide excision of injured tissues of the brain (the single desideratum of success) is not practical. Gross and Houdart, on the other hand, believe that to attain success in primary wound closure, it is sufficient to wash the cerebral tissues with warm serum and to lightly curette clots, bone splinters, or foreign bodies. Tanton, who is also a great partisan of primary wound closure, states

that complete disinfection of cranio-cerebral wounds is easy to obtain Willems has more recently formulated the same opinion

Moulouguet and Legrain believe the infectious action of a projectile is not negligible They offer an additional theoretical objection to primary closure They maintain that the pulsations of the brain in the case of open wounds eliminate secretions, bruised and soiled tissues, and minute bone splinters which have been overlooked at the primary operation

As regards the treatment of deeply implanted foreign bodies in the brain, Cushing believes that they can best be removed by the magnet The ideal treatment consists in the removal of projectiles at the primary operation, otherwise the operation must be regarded as incomplete There is far greater likelihood of the development of subsequent abscess than if the removal of the missile had been accomplished, but the forcing of an operation to the point of increasing the damage already done to the brain by penetration should never be done

Even good-sized foreign bodies may be retained without provoking symptoms, but, even so, late abscess is not infrequent, and the best advice is to extract the missile, if it can be accomplished without increasing the damage already done

Moulouguet and Legrain state that the extraction of foreign bodies by the electro-magnet, apart from being useless in the case of non-magnetic bodies, necessitates a complicated apparatus

In the matter of drainage of the brain, there is little discussion This should not be done with tubes for fear of causing ulceration Lumbar puncture should be performed in cases of meningitis and hypertension

Primary cranioplasty for loss of bone substance is not advised by Cushing except when the defects are large in the scalp or when the ventricle has been opened Secondary plastics, however, are frequently in order, as illustrated by a case in the preceding paper in which a celluloid plate was inserted after amputation of the hernia and bilateral decompression

Wounds of the skull repair spontaneously, but in most instances it is not bony Mayet studied a series of 21 cases of defects in the skull a year after injury and there was newly-made bone in no instance Occasionally, however, very small fragments of periosteum may regenerate bone substance and help to repair the loss, especially in small wounds

Cranioplastic operations have made much progress during the war, but they must not be attempted too soon First ascertain that there is no dormant infection or foreign body in the wound

Repairs may be made with non-living substances, such as celluloid, ivory, metal, lime paste or calcinated bone, or with living grafts of cartilage or bone and periosteum The latter may be taken from other bones of the body or from the neighborhood of the wound In the latter case it may be an osteo-periosteal flap, in which case there is greater assurance of life

In the case of non-living substances, the hole is simply corked, but in the

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case of the living grafts, on the whole to be advocated, the discrepancy is filled with a repairing substance. It may be feared that disturbances due to compression of the brain may result, and to obviate this danger a prophylactic decompression may be performed as in the case alluded to.

Statistics published by Villandre show the following results:

In those cases in which lime paste was used, 50 per cent were favorable, in cartilaginous cranioplasty, 96.8 per cent, in the case of grafts taken from the skull, 100 per cent.

FOREIGN BODIES OF DENTAL ORIGIN IN A BRONCHUS PULMONARY COMPLICATION*

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FOREIGN bodies of various kinds are undoubtedly lodged in the bronchi more frequently than they are recognized Weist reported 1000 cases, 103 (10.3 per cent) only were from the literature, 897 (89.7 per cent) were unpublished cases collected by Weist by personal communications It would seem possible that a correspondingly large proportion of cases of dental origin remains unpublished

Foreign bodies of dental origin include teeth, dentures, instruments, and other material used in dental operations Aspiration of infected blood or sputum is probably a more frequent source of infection than foreign bodies The occurrence of such infection is obviously greatly more difficult to prove, but the frequency of gross mouth infection in patients subjected to dental operations needs hardly be mentioned

There have been at the Mayo Clinic during the past four years 7 cases of pulmonary suppuration following dental operations or trauma In 2 cases the tooth was spontaneously expelled, in one it was discharged through a thoracotomy wound, and in one it was found at postmortem In the other cases no foreign body was found, but it is quite probable that they were also cases of infection from inhalation

I observed 6 of the 7 cases and have collected 45 proved cases from the literature These 52 cases form the basis of this report

FOREIGN BODIES IN THE 52 CASES

Teeth	37
Artificial teeth	4
Dentures	2
Root canal broach	2
Dental burr	3
Allen's dental cement	1
Plaster of Paris	1
Hard rubber from gag	1
Blade of forceps	1

The foreign body was lodged in the right bronchus in 21 cases, in the left bronchus in 19, in both sides in 1, and in the trachea in 1, the location was not stated in 10 The bodies were most frequently in the right lower lobe

In 26 cases the accident occurred during extraction under general anæ-

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thetia, in 12 under nitrous oxide, in 11 under ether, and in 3 under chloroform. In 3 cases false teeth were inspired, in 4 cases the foreign body was inspired during dental operations without anæsthesia.

The literature contains more or less fragmentary reports of other similar cases (Carpenter, Ricketts, Stokes, McCrae).

Symptoms and Signs—The symptoms may be divided into those which are manifest immediately following the inhalation of the foreign body, and those which arise from its prolonged presence in the respiratory tract. The most constant and characteristic immediate symptom is cough of varying intensity and persistence, associated symptoms are dyspnoea, cyanosis, wheezy respiration, pain in the chest, and nausea. In the 52 cases cough, more or less violent and spasmodic, was an immediate symptom in 27, pain or soreness in the chest in 13, and dyspnoea in 10. In one instance cough started after twenty-four hours, in another after four days. In 12 there was no cough. In 4 cases dyspnoea of a varying grade was the presenting symptom. In one only was there a sensation of a foreign body in a bronchus. It is noteworthy that in 7 cases (13.4 per cent) there were no symptoms whatsoever. In 16 of the series there were no serious pulmonary infections, in the remaining 36 there was evidence of pulmonary suppuration of varying grade. For convenience, in the further discussion the cases will be grouped on this basis.

In the 16 uncomplicated cases the accident occurred during general anæsthesia in 4, and during alcoholic intoxication in 1. No anæsthesia was used in 2, and no statement was made as to anæsthesia in 9. Symptoms were marked in 7, and not mentioned in 9. A diagnosis was made by the X-ray in 5, in 1 the plate showed only pleural thickening. In 8 there was no mention of an X-ray examination. With two exceptions the length of time the foreign body was present in the bronchus was short. In one a tooth was coughed up after three years, in another plaster-of-Paris fragments had been present for five years without symptoms other than a persistent spasmodic cough.

The foreign material was spontaneously expelled in 4 cases on the third day, the fifth day, during the third month, and three years after the accident, respectively. Early bronchoscopic removal was effected in 10. Two patients died, one from typhoid fever ten days after bronchoscopy, and one from tuberculosis following temporary recovery from an unsuccessful thoracotomy.

Complications—This group comprised 36 cases. In 22 the accident occurred during the extraction of teeth under general anæsthesia, in 2 others in which it followed extraction the anæsthesia was not mentioned, in 2 loose artificial teeth or dentures were inhaled, in 1 a tooth was inhaled during a general anæsthetic for an abdominal operation, in 1 pulmonary infection followed a kick in the face by a horse, resulting in the loss of several teeth.

Immediate Symptoms—In this group cough of varying severity asso-

ciated with other symptoms, such as dyspnoea, cyanosis, and pain in the chest, was manifest in 11. In 7 cases cough was the only symptom, in 3 there was no cough, in 10 there were no immediate symptoms, or they were so mild and transitory as to be practically negligible.

A latent symptomless period was present in 15. The length of the latent period was two weeks or under in 3, between two weeks and two months in 7, more than two months and under one year in 2, two years in 1, and eleven and one-half years in 1. There was no latent period in 13. The records in the remaining cases were indefinite on this point.

Late Symptoms—Cough, usually with purulent sputum, was present in 29 cases, hæmoptysis in 8, and pain in the chest in 11. The onset of late symptoms was gradual and without any intervening symptomless period in at least 13. The relation was not stated in 8. X-ray reports were mentioned in 16. The plates showed the foreign body in only 4 cases, an artificial tooth with a piece of denture in 1, a tooth in 2, and a dental burr in 1. Abscess was shown in 5 cases, one case diagnosed tuberculosis proved on postmortem to be bronchiectasis. A fluoroscopic examination revealed limitation of movement of the diaphragm in one case, negative X-ray findings for foreign body were reported in 12 cases.

It would appear on first thought that a diagnosis should be established by the fact that a foreign body passed down the pharynx. In the present series of cases the patient was usually unconscious at the time of the accident. In one case (Carpenter's) the patient believed that he had swallowed, not inspired, a denture with four teeth, its presence in the lung was never suspected and was only proved at postmortem after thirteen years. In one case only (Hubbard's) did the patient insist that the foreign body was in the lung in spite of negative X-ray and other findings.

In cases without immediate severe symptoms the operator may believe or fervently hope that the foreign body passed down the œsophagus instead of the trachea. In one case (Jarvis's) the dentist obviously had such hopes, in spite of the fact that the patient, a physician, had paroxysmal cough and other characteristic symptoms of foreign body in a bronchus immediately on awakening from anæsthesia. When the patient asked to see the tooth the dentist explained that it had broken and was thrown away. Three months later the physician coughed up the tooth.

In cases of multiple extraction, as in 22 instances in this series, a tooth or stump of a tooth is easily lost without being missed.

Treatment—Bronchoscopy was done for the removal of foreign bodies in 5 cases, in 3 of which the X-ray showed the foreign body. In the fourth case a second X-ray plate, taken after a positive clinical diagnosis of foreign body had been made, showed the foreign body. In the fifth case no X-ray was taken. In 2 of these cases the foreign body was removed at the first attempt, in 1 two unsuccessful high bronchoscopies were followed by a third successful low bronchoscopy after tracheotomy, in a fourth the bronchoscopies failed. Doctor Jackson had seen this case

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and believed the foreign body to be beyond reach of the bronchoscope. In still another case in which bronchoscopy failed, a first-stage operation was done for drainage and the patient died before the second-stage operation had been undertaken. Thoracotomy was done in 15 cases, in 2 of these the lung was resected. In the remaining 13 cases the operation was done for drainage of the suppurating process.

Results—Fourteen of the 36 patients with complications died, 16 made a complete recovery, and the result in the remaining 6 cases is not definitely stated. There were seven deaths in the 24 cases occurring since 1900.

Seven of the 14 patients who spontaneously expelled the foreign body recovered, and 3 died, the ultimate result was not stated or was uncertain in 4. In 3 cases an abscess requiring drainage developed after the foreign body had been expelled, in one case the foreign body was discharged through the drainage wound, and in one case the tooth was expelled after two and one-half years. Seven months later an abscess developed, and after two months the patient died. In 15 cases in which thoracotomy was performed 2 were followed by resection of the lung, both patients died; 1 died of exhaustion, and 1 of pulmonary embolus before the second-stage drainage operation. One died while being chloroformed for drainage operation. One improved so markedly following the preliminary rib-resection that the second-stage operation was not done. In the remaining 11 cases, 1 patient died, 1 was greatly improved, and 9 made a complete recovery.

POSTMORTEM FINDINGS IN 9 FATAL CASES

- 1 Bilateral bronchiectasis, empyema, tooth in bronchus
- 2 Pulmonary embolism
- 3 Large empyema fistula in lung, denture in pleural cavity
- 4 Abscess, ulcerated bronchus, tuberculosis
- 5 Abscess, tooth in bronchus
- 6 Abscess, empyema, tooth in bronchus
- 7 Massive gangrene of entire lung, tooth obstructing bronchus
- 8 Bilateral lower lobe bronchiectasis, tuberculosis, tooth in bronchus
- 9 Bronchiectasis, pericarditis, tooth in bronchus

DISCUSSION

In this series of cases the relationship between multiple extractions of teeth under general anaesthesia and pulmonary complication is striking. Multiple extractions under general anaesthesia were performed in 22 instances. Aspirative infection as a cause for pulmonary suppuration may probably be assumed to be sufficiently evident in the cases in which the tooth was later expelled, or in which an impacted tooth was found in the midst of a suppurative or gangrenous process in the lung. Perhaps the most striking evidence of all is shown in the case of Israël, in which a

tooth was found in an actinomycotic abscess of the lung. That aspiration of infected material from the mouth independent of teeth is a large factor in the causation of pulmonary infection cannot be so clearly demonstrated in the individual case, but much evidence has accumulated indicating that aspiration of infected material is one of the most common causes of abscess, gangrene, and bronchiectasis. As early as 1877, Schuller found that the introduction of clean foods into bronchi of rabbits through tracheal wounds is practically harmless, while the introduction of the same foods mixed with bacteria and filth results in a fatal pneumonia. Lung abscess following tonsillectomy has been reported frequently (Manges, Tewksbury, Bassin, Frank, and others). Kulbs found bad teeth and tartar (Zahnstein) in a large proportion of cases of lung abscess in which he operated. In a series of 56 cases of pulmonary suppuration at the Mayo Clinic in which operation was done, aspiration of an infection was probable in 25 per cent, the etiology was questionable in another 25 per cent, but it is probable that a large proportion of these were cases of aspirative infection.

The importance of early recognition of a foreign body in a bronchus is emphasized by the fact that in this series there was no mortality in the cases in which it was expelled or removed early by bronchoscopy. All the fatalities, with the exception of one death following lung resection, were in cases in which the foreign body had been present for a long period.

Positive diagnosis may be made by means of the history, the X-ray, or by bronchoscopy. It is important to remember, however, that each and all of these may be negative in the presence of a foreign body, as in 12 cases in this series. Symptoms and signs are suggestive, but in themselves are rarely conclusive. In many cases they have led to an erroneous diagnosis of tuberculosis.

The history of the case is of first importance. If the operator knows that a tooth has passed down the pharynx, and the patient immediately develops symptoms of bronchial irritation, the diagnosis is obvious. Even in the absence of symptoms, it should be assumed that the foreign body passed down the trachea rather than the œsophagus until the contrary is proved. No marked immediate symptoms occurred in 9 of the 22 cases and there was a later symptomless period in 16 of 35 cases. In one case it was of thirteen years' duration. The profession has been slow to recognize that a symptomless period does not constitute proof of absence of a foreign body. Jackson writes on this point: "Practitioners are heedless of and even scoff at the patient's suspicions that a long previously aspirated (or swallowed)¹ foreign body is the cause of present symptoms."

Examination by the X-ray is indispensable, and a positive plate establishes the diagnosis both as to the presence and the location of the foreign body. A negative X-ray, however, is not conclusive and in the presence of a diffuse shadow from pulmonary suppuration is of doubtful value. In

¹ Inserted by the author

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the 16 uncomplicated cases in this series, the X-ray was positive in 6 of the 7 cases examined, but in the group with complications it failed to show the foreign body in 12 of the 16 cases examined

In early uncomplicated cases bronchoscopy in skillful hands is the best method of diagnosis and of removal. The indications for bronchoscopy for a foreign body as enunciated by Chevalier Jackson are as follows

- 1 The appearance in the roentgenogram of a foreign body or of any suspicious shadow

- 2 Cases in which a clear history is given of the patient's having choked on a foreign body, and in which the foreign body was not afterwards found

- 3 Cases in which there are signs of stenosis of the trachea or the bronchus

- 4 In any case suspected of bronchiectasis

- 5 In the absence of any history of a foreign body, the patient giving symptoms of pulmonary tuberculosis, without the finding of bacilli in the sputum, and especially if the physical signs are at the right base, and above all, if there are also physical signs of pleural effusion

- 6 In case of doubt, bronchoscopy should be done

Jackson recognizes no absolute contra-indications to bronchoscopy

TREATMENT

Expectant treatment is employed in the hope that the foreign body may be expelled spontaneously, bronchoscopy and thoracotomy are the alternatives, after the foreign body has been recognized

The question of the likelihood of the expulsion of the foreign body is often raised in the consideration of the advisability of bronchoscopy. In this series the tooth was expelled in only 3 of 13 cases before the onset of pulmonary suppuration. The tooth was expelled in 13 of 33 cases after suppuration had developed. Six of these patients recovered, but thoracotomy had to be done in 4 instances. Three patients who received no further treatment died. Jackson's attitude toward the question of spontaneous expulsion is as follows: "We do full justice to our patients when we tell them that while the foreign body may be coughed up, it is very dangerous to wait, and further that the difficulty of removal increases with each hour the body is allowed to remain."

If the foreign body has not been recognized, however, or the patient has been treated expectantly until suppuration has set in, the results following bronchoscopy are not so favorable. In 5 such cases in this series in which bronchoscopy was done the foreign body was removed in only one. It may be impossible to locate the tooth and it must be seen in order to be removed. Furthermore, its removal in the presence of pulmonary suppuration becomes only an incident. The important consideration in such cases is the suppurating focus. For this complication thoracotomy for drainage has given the best results. If the focus is in the form of a localized solitary abscess, a drainage operation is the

operation of choice. If the cavity is multilocular or if there is a bronchiectasis, any form of treatment is likely to yield a high morbidity and mortality. Massive gangrene is uniformly and quickly fatal.

The table of postmortem findings is uncontrovertible evidence of the possible etiologic relationship of foreign body aspiration to abscess, gangrene, and bronchiectasis.

With regard to details of dental operative technic for prevention of accidental aspiration of foreign bodies, Doctor Gardner of the Mayo Clinic in a personal communication expressed himself as follows:

"The patient should be watched quite as carefully with a local anæsthetic as with a general. The use of gauze sponges in no way interferes with the work of the operator, it prevents the inhalation of a foreign body during operation and cares also for the hemorrhage. Furthermore, the dentist may, by careful examination of the teeth before operation, ascertain if the work might displace pieces of tartar, fillings, or even the teeth themselves during a general anæsthetic. The condition of the patient undergoing any operation often requires the use of a gag during an ether anæsthetic, and the anæsthetist should know the condition of the patient's teeth before the anæsthetic is started, since such an instrument often displaces from a tooth foreign bodies which might be inhaled."

SUMMARY

1 Aspiration infection of the lungs is most common in operations about the mouth following general anæsthesia.

2 Symptoms may be immediate and continuous or there may be an intervening symptomless period of months or years. There may be no immediate symptoms.

3 The most constant and characteristic immediate symptoms are cough, dyspnoea, wheezy respiration, and pain in the chest. The late symptoms in varying number and degree are those of pulmonary suppuration.

4 Late symptoms of foreign-body infection often simulate phthisis, and that is the diagnosis often made.

5 Positive diagnosis rests essentially on history-taking, X-ray, and bronchoscopy. The history may be that of having "swallowed" the foreign body.

6 Bronchoscopy for diagnosis is indicated in any early doubtful case.

7 Spontaneous expulsion of small irregular foreign bodies of high specific gravity, especially teeth, is always doubtful. Spontaneous expulsion often occurs only after an abscess has formed.

8 Bronchoscopy is the only treatment to be considered in early uncomplicated cases. In cases in which there is suppuration, thoracotomy for drainage gives the best results.

9 In fatal cases death is usually due to abscess, bronchiectasis, or gangrene of the lung, any of which may be complicated by empyema.

10 Tuberculosis may coexist with a suppurative process.

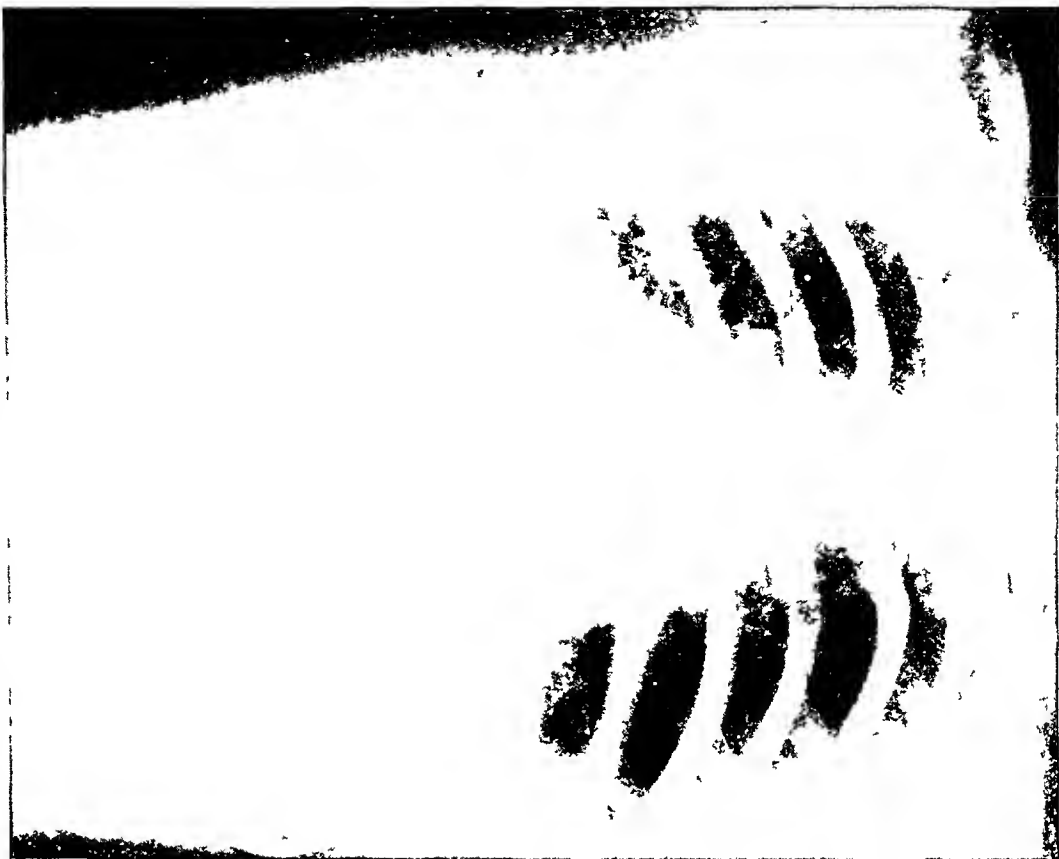


FIG 1 —(169958) Rontgenogram made eight months after teeth extraction



Fig. Dr. J. L. 19, tooth in alveolar terminal
branch of the 1st R. 1900



FIG 2 —(169958) Drawing of bronchectatic lung, showing tooth in
dilated terminal bronchus of right lower lobe



FIG 3 — (240703) Röntgenogram made before operation about two and one half months after teeth extraction. Note the fluid level.



FIG 4 — (240703) Röntgenogram made eighteen days after operation.

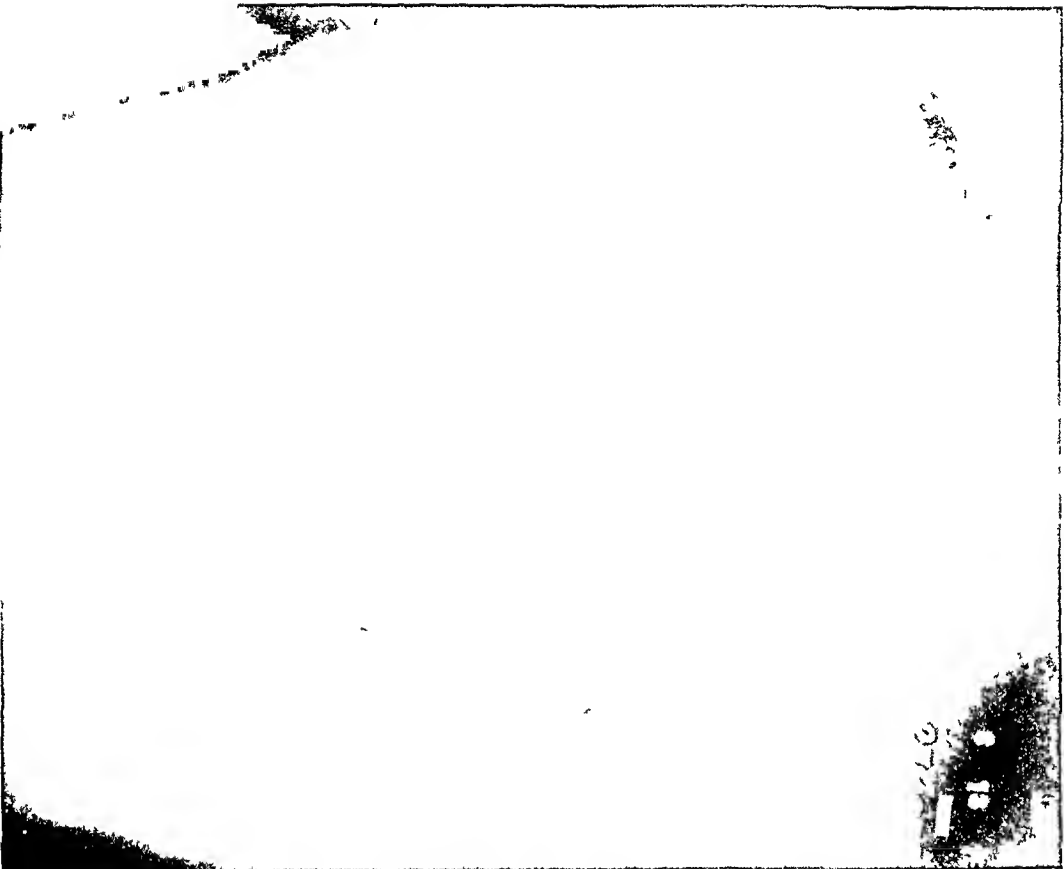


FIG 5 —(281586) Rontgenogram made nine days before operation



FIG 6 —(274952) Rontgenogram made two days before expelling tooth

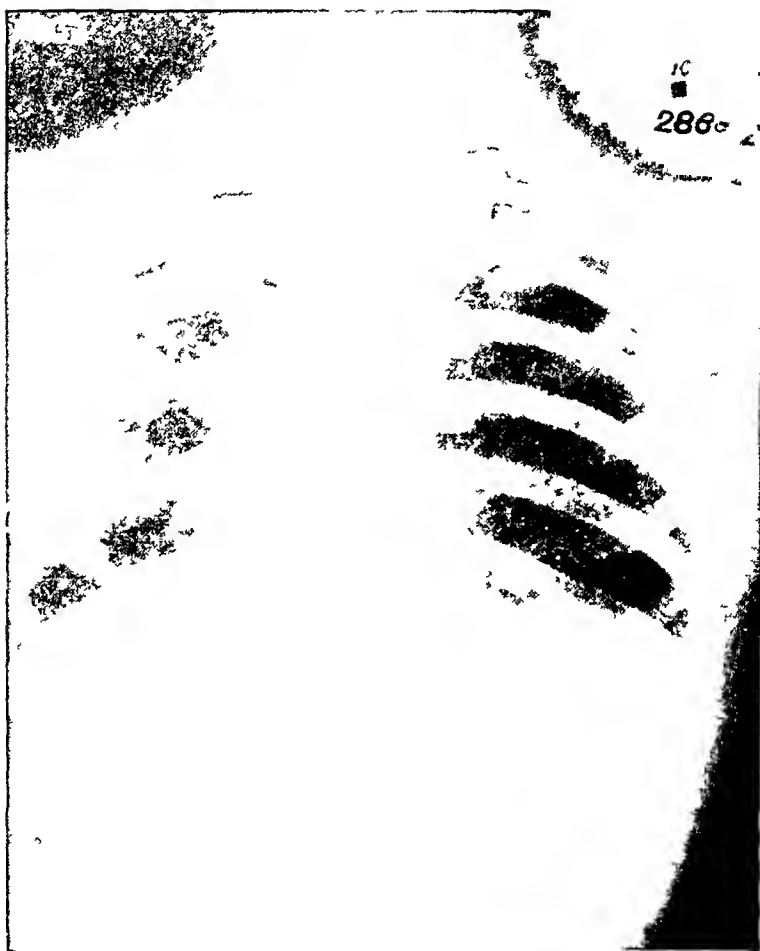


FIG 7 —(286912) Röntgenogram made about one and one half years after patient expelled two pieces of teeth and silver filling

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CASE I (169958) —E R F, aged thirty-four years, an anæmic, emaciated woman, came to the clinic August 21, 1916, complaining of cough with sputum, pain in the back, fever, weakness, and loss of weight

The illness began in January, 1915, following teeth extraction under general anæsthesia. The patient began to cough immediately on awakening from the anæsthesia and the cough had persisted. Pulmonary tuberculosis was diagnosed for which she was treated for a number of months. September, 1915, an X-ray was taken and a tooth was revealed in the lower part of the right lung. Three attempts were made to remove the tooth by bronchoscopy but all failed. Thoracotomy was then done, but the tooth was not found.

When the patient came to the clinic her cough was very severe and persistent, preventing sleep. Pain in the back with fever had started six weeks before. She had lost 30 pounds in weight. The sputum was foetid, greenish, and amounted to upward of a pint in twenty-four hours.

At the time of examination the hæmoglobin was 76 per cent, the leucocyte count 17,600, the systolic blood-pressure 117, the diastolic 60, the pulse 96, and the temperature 100.5°. Resonance was impaired and breath sounds were diminished at both bases. There was a scar of thoracotomy below the angle of the right scapula. The skiagram showed shadows at both bases which were believed to be due to the thickened pleura at the right and a small amount of fluid at the left base. The appearance of the right lower lobe suggested tuberculosis. The clinical diagnosis was old abscess of the right lung, and left pleurisy with effusion. August 25th a bronchoscopic examination was made. The tooth was not found, but much pus was seen coming from the right bronchus. Thoracentesis of the left pleural cavity yielded pus. August 28th a first-stage operation was done for drainage of the abscess. The patient died, however, before the second-stage drainage operation could be performed.

Necropsy showed a bilateral bronchiectasis and left empyema. The broken tooth, surrounded by an abscess, was found lying within 2.5 cm. of the lower surface near the lateral aspect of the lung (Figs 1 and 2).

CASE II (216141) —J R, a man aged sixty-six years, came for examination December 8, 1917. This patient appeared older than his years, probably due, in part, to exposure and to alcoholic excess. His illness began in October, 1917, after teeth extraction under ether anæsthesia. A number of teeth were broken off, and considerable bleeding followed for two weeks. Immediately after the operation the patient developed a constant dull pain in the right lower chest anteriorly. These symptoms persisted for two weeks, when he suddenly vomited a pint of pus, coughing and a large amount of purulent sputum persisted, especially during the month before examination, and kept him awake a great deal at night.

Examination of the chest showed an area of flatness in the right axilla. The hæmoglobin was 50 per cent, and leucocyte count 13,000. The systolic blood-pressure was 140, the diastolic 66, the pulse 84,

and the temperature normal. Repeated sputum examinations were negative for tuberculosis bacilli. The skiagram showed dense infiltration in the upper portion of the right lobe with cavitation. The patient was a poor surgical risk and he was kept under observation in the hope that there might be some improvement. His symptoms instead of subsiding, however, became more aggravated. Four weeks later the skiagram showed marked extension of the purulent process, operation was therefore advised. The patient was transfused once before the operation by the sodium citrate method, receiving one-half litre of blood. A two-stage drainage operation under local anaesthesia was performed because of the absence of pleural adhesions. An abscess cavity the size of a large orange and containing a mass of gangrenous lung tissue was found. The patient's convalescence was rapid, four months after the operation he had gained 50 pounds in weight. He was dismissed from the clinic with a small sinus. Five months later a portion of a tooth was found in the dressings. The sinus then rapidly closed. In September, 1919, the wound was solid and there were no symptoms referable to the old pulmonary lesions.

CASE III (235649) —Mrs N F, aged thirty-nine years, presented herself at the Mayo Clinic June 18, 1918, complaining of persistent cough with purulent sputum and occasional hæmoptysis. Her illness began in August, 1917, following teeth extraction under ether. The day following the operation she coughed up 4 or 5 ounces of dark, clotted blood having a very foul odor. She continued to cough and to raise large amounts of pus and blood. She also developed pleurisy with effusion, for which a thoracotomy was performed in September, 1917, and a secondary operation for drainage in November.

The patient coughed frequently during the examination, raising a bloody purulent sputum having a very foul odor. There was dullness in the left axilla, moist râles, and tubular breathing toward the apex. The hæmoglobin was 80 per cent and the leucocyte count was 9400. The systolic blood-pressure was 126, the diastolic 70, the pulse and temperature normal. There was distinct clubbing of the fingers. The sputum was repeatedly examined for tuberculous bacilli, but none were found. The skiagram showed infiltration of the lower left lobe of the lung, and a diagnosis of probable abscess was made. An exploratory aspiration was performed in the region of the thoracotomy incision. The first operation was interrupted by an epileptiform seizure followed by lapse of consciousness for about five minutes. Six days later a tubular cavity was opened and drained. The patient left the hospital two weeks later, the wound drained for some weeks and then closed. There have been no further symptoms.

CASE IV (240703) —J K S, a man aged forty-five years, came for examination August 1, 1918. He appeared to be very sick and complained of cough with much foul sputum. He had had several teeth extracted in May, 1918. Two weeks later he began to cough, raising

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foul-smelling sputum, sometimes 24 ounces each day Slight swelling of the legs had been noted

The physical examination disclosed marked loss of weight, foul breath, systolic blood-pressure 110, diastolic 60, pulse 80, and temperature 98° The right chest wall was markedly retracted and there was an area of dullness about the level of the second and third ribs anteriorly Breath sounds in this region were intensified No tuberculosis bacilli were found in the sputum The skiagram showed marked infiltration in the upper right lobe which was diagnosed abscess with cavitation The fluoroscopic examination revealed a fluid level with distinct splashing

A two-stage operation was performed for drainage of the abscess, which was found to lie about in the midaxillary line The abscess contained little pus, but some very foul-smelling necrotic tissue was removed The convalescence was slow, although progressive, and the patient left the hospital with a bronchial fistula January 19, 1919, the patient reported by letter that he had gained 38 pounds in weight, that the fistula had closed, and that there were no symptoms referable to his former illness (Figs 3 and 4)

CASE V (281586) —J A C, a rather frail looking man, aged sixty-three years, came to the clinic July 23, 1919, complaining of cough with sputum, weakness, and loss of weight His illness began in October, 1918, when he was kicked in the face by a horse The kick was a glancing blow, breaking the bridge of the nose and knocking out several teeth He was knocked unconscious by the blow There was some cough immediately on recovering consciousness, and the patient believes that he must have swallowed a great deal of blood, because his stools were black following the accident Eight weeks later a corrective operation under cocaine was done on his nose He then had a mild attack of pneumonia, he was in the hospital for four weeks, and had several attacks of hæmoptysis One month after recovering from pneumonia he developed severe pain in the right chest with fever running up to 103° Twenty-four hours after the onset of this illness the "abscess broke," and a pint of pus was coughed up There has since been a persistent cough with sputum, amounting to about a teacupful in twenty-four hours, progressive weakness, and a weight loss of between 20 and 30 pounds (Fig 5)

Slight dullness was found at the right apex anteriorly, with marked amphoric breathing The respiratory excursion at the right apex was lagging Many teeth were missing, and those remaining showed marked pyorrhœa and some were carious The hæmoglobin was 58 per cent, and the leucocyte count 16,000 The systolic blood-pressure was 134, the diastolic 84, the pulse 88, and the temperature 101° Sputum examination for tuberculosis bacilli and elastic tissue was negative The skiagram showed a large abscess in the upper lobe of the right lung The clinical diagnosis was probable aspiration abscess A two-stage drainage operation was performed as pleural adhesions could not be definitely made out A deeply situated abscess about 3 inches in diameter was opened and drained The

convalescence was uneventful and the patient went home three and one-half weeks following operation in good general condition. He had no cough or sputum at this time and had gained 15 pounds in weight.

CASE VI (274952) —Mrs J S, a thin, rather frail looking woman, aged thirty years, presented herself June 12, 1919, complaining of headache and pain in the abdomen which began following childbirth January, 1919. In May, 1919, the patient was given ether for teeth extraction. She began to cough immediately on awakening from the anæsthesia. The cough, paroxysmal in character and worse at night, continued and was accompanied by more or less pain in the lower substernal region. The expectoration was mostly foamy mucus and moderate in amount. Perspiration was profuse at night, vomiting was frequent.

The patient was a poorly developed woman with marked evidence of loss of weight. At the time of examination the hæmoglobin was 64 per cent, and the leucocyte count 9000. All the teeth were missing. There were râles and increased breath sounds at the right apex. The right base was dull to percussion. The sputum was negative for tuberculosis bacilli. The X-ray examination showed pleural thickening with probable fluid at the right base. The diagnosis was that of general debility with probable slight right pleural effusion. The question of the presence of a foreign body was raised, but there was no definite evidence, and the patient was discharged without surgical treatment. June 15, 1919, during a very severe paroxysm of coughing she expelled a tooth. The cough and expectoration immediately became somewhat less, but at the last report, August 7, 1919, she still had pain in her back and some cough (Fig. 6).

CASE VII (286912) —Mrs A K, aged thirty-three years, presented herself September 1, 1919, complaining of a cough with purulent sputum, weakness, and loss of weight. The onset of her illness dated back nineteen months, following extraction of many teeth under general anæsthesia. She began to cough immediately on awakening from the anæsthesia, the cough persisted. Six weeks after the teeth extraction she coughed up two pieces of tooth, and twelve weeks later a silver filling. The cough, however, continued, the sputum was foul and amounted to a cupful in twenty-four hours. She had pain in the right chest, night sweats, and occasional hæmoptysis. The symptoms instead of subsiding after the foreign body was expelled became progressively worse.

At the time of examination the patient was sitting with a basin before her, coughing more or less continuously, and raising very foul purulent sputum. The systolic blood-pressure was 100, the diastolic 60, the pulse 72, the hæmoglobin 80 per cent, and the leucocyte count 5000. The sputum examination was negative for tuberculosis bacilli. The skiagram showed a questionable shadow just behind the heart at the cardiophrenic angle. Because of the incessant cough and large amount of sputum, it seemed advisable to do an exploratory operation notwithstanding the meagre X-ray and physical find-

ings September 6, 1919, a first-stage operation was done for drainage of the abscess. Portions of the ninth, tenth, and eleventh ribs were resected, and the lung was sutured to the parietal pleura. Pneumothorax had not occurred so far as could be ascertained. A week later an exploratory aspiration was performed for abscess. The aspiration yielded only air which was entirely without odor. Following this negative aspiration the patient began to improve, the cough and sputum practically ceased within a week, and the patient began to gain in weight. It seemed probable that a local pneumothorax had been produced which was sufficient to bring about the good results. A letter from the patient's family physician October 17th stated that she was in excellent condition, but October 30th a second letter was received stating that there was a recurrence of the cough and sputum (Fig 7).

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MULTIPLE HEMORRHAGIC FOCI IN BONE

CHRONIC HEMORRHAGIC OSTEOMYELITIS

BY GEORGE BARRIE, M D
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THROUGH the courtesy of Dr Virgil P Gibney, Surgeon-in-Chief to the New York Hospital for Ruptured and Crippled, the writer is able to report a rare and interesting type of multiple hemorrhagic granulation tissue lesions in bone

The exploratory operation performed upon the lesions our patient presented, disclosed a highly vascular structure presenting the gross appearance of healthy granulation tissue. The mass completely filled the destroyed areas of bone. This picture is typical of a regenerative effort in its reaction to injury.

Because of the gross appearance of the process and the histopathologic data the microscopic studies revealed, the title given this paper of multiple hemorrhagic foci in bone, or chronic hemorrhagic osteomyelitis, seems the most fitting designation for the presenting pathologic pictures. The cause or causes of the initial destructive process or injurious agent or agents bringing about these reactions or responses to injury will be discussed further on. What it is wished to particularly emphasize here is the well-established view expressed in modern pathologic studies, that inflammation is a reaction to injury, evidenced by attempts at repair.

A primary effort at regeneration and reconstruction in all connective tissue processes always has for its beginning the formation of granulation tissue. Such a process in bone is very properly termed an osteomyelitis even though there is no evidence presented of pus or pus formation. The view that the formation of granulations in any lesion or lesions is confirmative of an attempted repair seems beyond dispute.

We are able to show definitely in our case of multiple lesions and in numerous instances where complete studies of the solitary inflammatory process has been made, that they exactly simulate and conform to all the criteria presented governing a diagnosis of granulation tissue structure.

All available evidence points to the conclusion that these pathologic conditions are the result of and follow bone destruction. The known etiologic factors bringing about bone destruction and producing the various forms of osteomyelitis are the spirochæte, tubercle bacillus, infectious bacteria and parasites, traumata, malnutrition, and metabolic change, apparently due to endocrinal glandular lack of balance. The grade or degree of such osteomyelitic process cannot always be determined from clinical findings.

The case presented herein makes the fourth published in American medical literature, in which multiple hemorrhagic foci (hemorrhagic osteomyelitis) have been studied in their gross and microscopic pathology

CASE I—Crile and Hill were the first to record a case of multiple bone lesions presenting similar findings, under the title of "Multiple Giant-Cell Sarcoma." The patient was a young unmarried woman, aged twenty-two years. X-ray pictures taken of the skeleton showed numerous bones involved in the pathologic process. Operation was performed on a lesion in the right tibia, and the contents studied from its gross and microscopic pathology. The findings presented a picture from which a diagnosis of multiple giant-cell sarcoma was made. No direct etiologic factor or factors were ascertained. The history of the case, in part, states that the patient's mother had suffered from syphilis, her father had diabetes. She had chronic discharge from ear since childhood. No evidence of acquired syphilis. Had been under specific treatment for some time without improvement. It is interesting, however, to note that the exploratory wound gave no evidence of healing until the patient was put upon iodide therapy, prompt healing of the wound then resulted.

Ten years after the above findings were reported by Crile and Hill, the same patient was seen in New York by Dr. I. S. Hirsch, who has been kind enough to furnish me with the following data:

"This patient turned up in Bellevue Hospital in 1915 or 1916, with numerous masses, apparently attached to all the bones.

"A radiographic examination showed multiple multilocular cystic tumors, which had the typical appearance of what we now recognize as giant-cell tumors or multiple fractures. The patient was in good general condition."

The second case appearing in American literature, presenting a similar gross and microscopic pathology, was first published by Adolph Hartung in 1914, under the title of "Some Unusual Bone Lesions," in diagnosis of bone cysts being made from the roentgenologic pictures obtained for study.

CASE II—The same patient was presented in 1915 by Kanavel at a meeting of the Chicago Surgical Society. Kanavel had operated upon two of the lesions, and reports, in part, as follows:

"In both cysts removed we found a granulomatous type of tissue, it was rather tenacious, and around each one of these cysts was a thin lamella of bone. In both cysts the lamella of bone was broken down and the cyst material scraped out. One cyst was packed on account of bleeding and the other was closed."

The study of the microscopic sections, made by Bissell, taken in connection with Kanavel's description of the gross pathology of the lesions in this case, would seem to group it with those of Crile and Hill, Haussling and Martland and the one here reported by the writer.

Hartung and Kanavel's patient was a male, aged thirty-four years. The lesions began developing nine years previously. The diagnosis of multiple bone cysts does not seem justified, in view of Kanavel's findings of vascular osteomyelitic foci.

A careful study of many solitary lesions in bone has impressed and confirmed the writer in the view that practically all fibrocystic and cystic

lesions are secondary processes and further that most of them arise from granulation tissue, this latter structure representing a primary effort at replacement in destroyed areas

As pointed out by Fuller, in discussing Kanavel's case, the term "bone cyst" is quite misleading and it is usually incorrect. One should never be content to rest upon a diagnosis of "bone cyst" from X-ray findings alone. The latter frequently exhibits an area or areas of osteolysis, in pathologic processes in bone, commonly termed bone cyst, or cysts, that covers other definite diseased conditions.

The roentgenologist unfamiliar with the gross and microscopic pathology attending bone lesions is handicapped in reaching confirmatory diagnostic conclusions, particularly by dependence upon X-ray studies alone. It should also be borne in mind that even possessing such special knowledge the roentgenogram must frequently fall far short of expressing the true pathology many lesions present. The X-ray is of inestimable value as a diagnostic aid, but, as a rule (excluding fractures), positive conclusions should not be made regarding bone pathologic processes regardless of other cumulative findings.

In the opinion of the writer, it is more than probable that operative investigation of cases termed "multiple bone cysts" would develop a greater number exhibiting lesions of the type here reported. The writer is also of the opinion that a progressive effort at repair in these hemorrhagic osteomyelitic processes is evidenced by the formation of fibrous tissue with cystic areas. Such so-called cysts usually result from contraction, due to granulation tissue metaplasia, rather than from tissue degeneration.

It may readily be assumed that where multiple lesions of this character present themselves, different phases of the affection showing efforts at repair are to be observed, not only in the different lesions but in structures in a solitary process.

The findings of highly vascular granulation tissue and microscopic giant-cell content in one area in Crile and Hill's case, which they termed "multiple giant-cell sarcoma," should not lead to the assumption that each of the other lesions necessarily presented an exact gross or microscopic similar pathologic picture.

The cases reported by Percy, Willard and Andrus, Da Costa, Funk, Bergeim and Hawk, and numerous other observers, while apparently closely allied in relation to the etiologic factors bringing about these multiple destructive processes in bone, cannot be included in this group because no evidence is presented exhibiting attempts at repair by the formation of vascular granulation replacement tissue.

It is in connection with the appearance of this reparative hemorrhagic structure filling destroyed areas in bone that much confusion has arisen and in which seemingly errors of diagnosis have frequently been made. The belief that such masses are in themselves sarcomata, is based generally upon the fact that numerous giant cells are frequently present

Recent studies and research apparently show rather definitely that the type of giant cells contained within such masses have no tumor forming power. Their function seems to be altogether scavenger. They also appear to occur in the greatest profusion in areas of ancient hemorrhage, acting as phagocytes. To a much less degree they are found in areas of cellular necrosis and fibrosis.

The third case belonging to this group is the one of Haussling and Martland. They describe the clinical picture in their study as resembling a multiple myeloma. Bence-Jones protein bodies were never found in the many urinary examinations made nor were any abnormal blood conditions present, spinal fluid tests were also negative. The microscopic and gross pathologic studies of the removed tissue finally proved the lesions to conform to the pictures presented in the so-called medullary or myelogenous giant-cell sarcomata, or multiple chronic hemorrhagic osteomyelitis of Barrie.

CASE III—The patient was a female, aged twenty-five years, married, four normal births, one miscarriage (last normal delivery of a full-term healthy child one month before admission). Nine months before admission suffered from fracture of lower end of right femur, normal recovery. Examination of the patient elicited palpable masses in the right orbital cavity and superior maxilla (observed many months), right and left clavicles, left tibia and seventh rib on right side. Rontgenograms taken of the skeleton showed, in addition to the above, areas of osteolysis in right femur, right and left fibula, right humerus and pelvis.

All lesions were operated upon, curetted thoroughly and closed. They healed by first intention and gave no later evidence of infiltration. With the exception of the humerus, all the processes presented a gross picture of firm, red, granulation tissue. The lesion in the humerus was fibrocystic in character.

This interesting case is again under observation by Haussling and Martland, four years after operative interference. They state the patient is in good condition and are about to publish a supplementary report on the case.

CASE IV—This patient, while on his way to the hospital for observation and treatment, was run into by an automobile truck and had two ribs fractured.

History—November 21, 1919. George M., male, white, Russian Hebrew, aged fifty years, married, youngest child eighteen years old, wife has not had any miscarriages, denies venereal infections.

Fifteen years ago had an attack of "sciatic rheumatism" lasting one year. Eight years ago first felt weakness and pain in both legs with sticking pains in soles of feet, trouble lasting two months. The following winter suffered from a repetition of same symptoms more severe in character, lasting for same period of time. During both attacks had difficulty in going up and down stairs and continuously had feeling of exhaustion. No urinary symptoms nor gastric crises. Six years ago all teeth were extracted in hope that pain in feet and legs might be relieved. For past six years has been laid up every winter because of disability of lower extremities. During summer months has always been free from pain but suffers -



FIG 1 —Anterior and posterior views of patient described

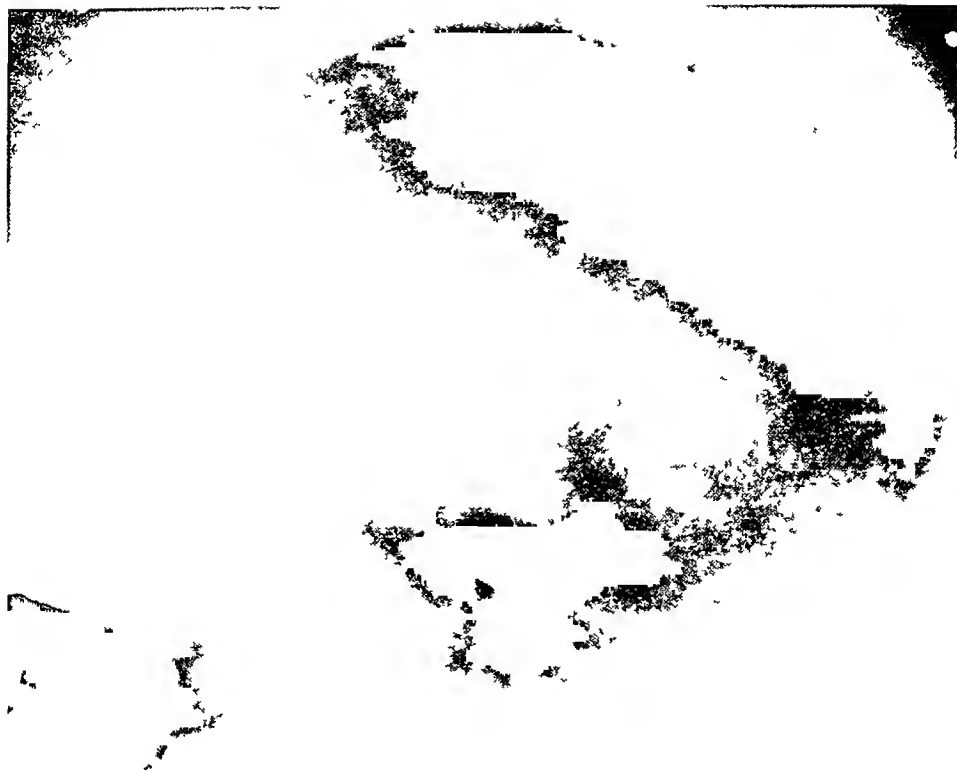


FIG 2—X ray showing thickened skull with translucent spots

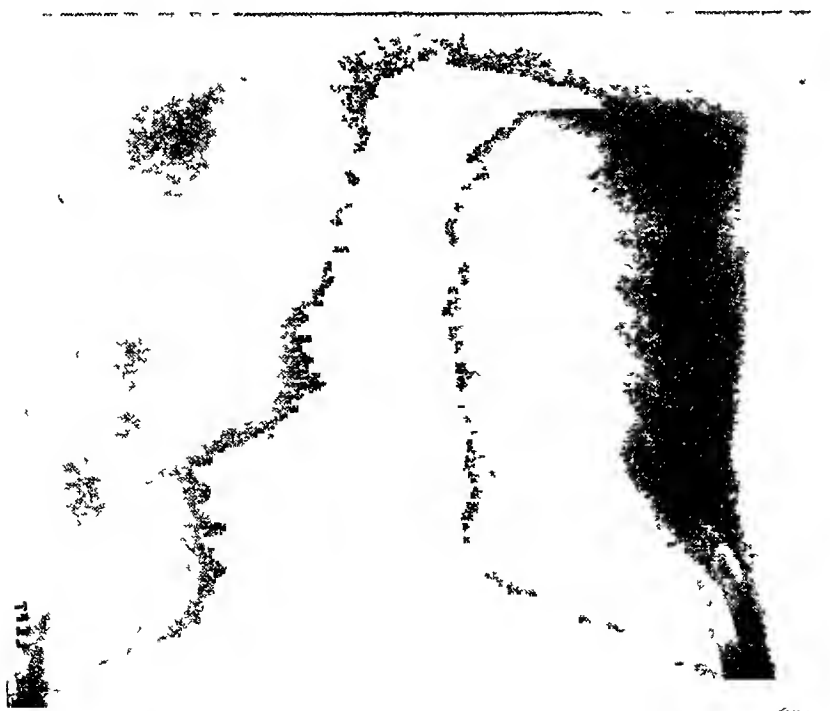


FIG 3—X ray showing areas of osteolysis and fractures through pathologic processes in both ribs



FIG 4 —X-ray showing areas of osteolysis and translucency in both femora



FIG 5 —X-ray showing large area of osteolysis in left tibia, areas of osteolysis and translucency in right tibia

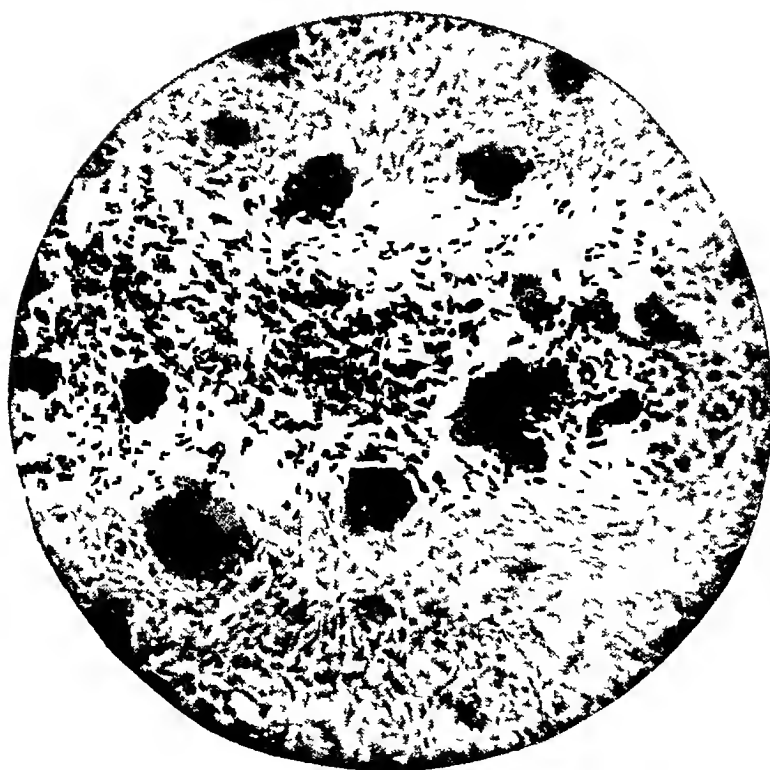


FIG 6 —Multiple hemorrhagic osteomyelitis from tissue removed from tibia Low power photomicrograph

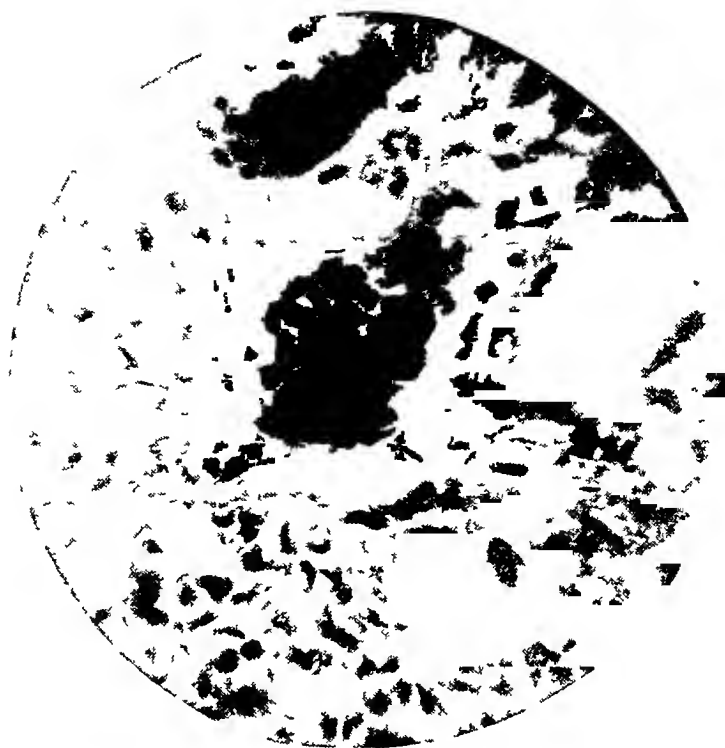


FIG 7 —Multiple hemorrhagic osteomyelitis tissue from same patient High power photomicrograph

from same feeling of exhaustion Has never suffered from headaches In 1915 a neurologic diagnosis of amyotrophic lateral sclerosis was made, at that time patient exhibited weakness in left arm and leg, with marked muscle atrophy of left hand and both legs

Patient is certain that nodules in legs have been present less than a year Has had great difficulty about eating since using false teeth

Examination—Patient's apparent general condition not especially good Neurologic examination negative Head not enlarged, upper extremities negative Pressure over eighth, ninth, and tenth ribs beyond axillary line causes excruciating pain, abdomen negative, urologic examination shows chronic vesiculitis Tenderness upon pressure over right femur, pressure over left causes severe pain Enlargement size of a hazel-nut in upper fourth anterior surface right tibia, also localized area of tenderness lower fourth same bone Left tibia exhibits enlargement size of a hen's egg mid third anterior surface

X-Ray—Exhibits areas of osteolysis in long bones of lower extremities, ribs on right side and small area in the thickened skull Ribs fractured through pathologic areas

Blood and spinal fluid Wassermann negative Differential blood-cell counts negative Numerous urinary examinations for Bence-Jones protein bodies were negative

In spite of the negative Wassermann findings, the writer made a diagnosis of multiple gummata, and had patient put upon specific treatment which was pursued for several weeks without apparent improvement and was dropped because of a developing nephritis which cleared up on disuse of the specific treatment Several members of the hospital staff regarded the process as one of multiple myelomata

The patient consented to an exploratory operation, which clarified the diagnosis The gross appearance of the pathologic tissue exhibited the typical picture of a hemorrhagic osteomyelitis, which was later confirmed by microscopic study

Operation—A vertical linear incision 3 inches in length was carried through skin to bone over the site of lesion in the left tibia A wedge of bone $2\frac{1}{2}$ by 1 inches was then removed, exposing the highly vascular soft tissue contents There was no lining membrane, the structure being firmly adherent to the bony mural surfaces Thorough curetting caused such profuse hemorrhage that it was found necessary to firmly pack the cavity for forty-eight hours, after which closure was made under novocaine anæsthesia Healing was primary

Histopathologic reports by Professor Ewing, Doctor Martland, Doctor Jeffries, and others are uniform in their findings regarding the cellular picture of this lesion Doctor Ewing states

"The section of bone tumor which you sent me shows the structure of what is commonly called benign giant-cell sarcoma of epulis type It is composed almost entirely of the characteristic giant cells,

many of which surround empty spaces which are often apparently blood channels. With the giant cells are an unusual number of large clear cells resembling endothelial cells from which apparently the giant cells are forming. Here and there are small fragments of bone undergoing simple absorption, in which process the giant cells do not seem to be participating. There is very little stroma and there are very few of the small spindle cells which make up a good portion of many such lesions.

"I have no objection to interpreting such a lesion as inflammatory, yet many of these processes have more definite features of a neoplasm."

It is, of course, altogether too speculative to venture an opinion regarding the causative factors that have brought about this patient's systemic bone disease. Some points noted in the history are, however, suggestive.

First, the condition of the patient's teeth was so bad several years ago that all were removed. One may quite readily conceive of the possibility of a general hemal infection arising from this cause. One may also understand that certain strains of vegetative bacterial growth possessing exceedingly low-grade virulency may perhaps have a selective predilection for tissues rich in mineral salts. The drawback to this hypothesis is that bacteria have not been observed in lesions of this type.

The second suggestive causative factor in our case is the fact that following removal of the patient's teeth he has had difficulty in masticating with an artificial set, has suffered great discomfort, and states that he has been unable to partake of the various foods necessary for health. In other words, since the removal of his teeth he has been in a state of under-nutrition and has slowly and steadily lost weight. Numerous experiments have definitely shown that food intake deficient in lime salt content is always reflected in the production of bone changes similar to some of the "malacias of von Recklinghausen." It seems probable that this case belongs in the same group. Since our patient has been put upon a generous diet, rich in lime salt content, and daily intake of 15 grains lactate of calcium, his general physical appearance has much improved.

The pathologic pictures the vascular granulation tissue masses exhibit, while recognized as being secondary processes, should be regarded as separate definite distinct entities, they are new regenerative efforts that have for their object restoration of destroyed areas.

In order to exactly cover the pathology that these products of reaction to injury present, both in their gross and microscopic studies, the term "multiple hemorrhagic osteomyelitis," while perhaps not altogether euphonious, seems the most fitting and scientifically correct term to use. The multiple lesions of this character do not lend themselves to the view that the condition is malignant nor do they conform to the latest definition of a tumor as propounded by Ewing, broad as his definition is, namely, "a tumor is an autonomous new growth of tissue."

Foreign literature contains many detailed reports of cases and studies of the pathology of these multiple lesions, the Germans and Austrians record the greatest number of observations. This is probably largely due to the pioneer work of von Recklinghausen and the stimulus his studies gave those interested in bone pathologic conditions. One still finds voluminous quotations regarding *ostitis fibrosa*, as described by him in 1891, but very few regarding his revised views given in great detail in his unfinished work published in 1910. Many observers have reported the multiple lesions containing vascular granulations as bone cysts, but always have associated such so-called cysts with *osteomalacia*, *ostitis fibrosa*, *ostitis deformans* and cysts in so-called giant-cell sarcoma.

Rehn, in 1904, was among the first to observe and describe a case belonging to the group under discussion. The gross and microscopic pathologic findings in his case coincide with the pictures of so-called myeloid sarcoma, giant-cell sarcoma, myeloma, giant-cell tumor and hemorrhagic osteomyelitis. His paper was published under the title of "Multiple Knochen Sarkome mit Osteitis Deformans." Bloodgood regards this contribution with its studies of microscopic findings as one of the best in foreign literature. Bloodgood also gives a résumé of the foreign literature covering these multiple lesions up to 1910. He has grouped them under the general headings Multiple Cysts, *Ostitis Fibrosa*, Giant-cell Sarcoma. He found 23 cases reported, as follows:

Multiple cysts in <i>ostitis fibrosa</i>	12 cases
Multiple cysts in <i>ostitis deformans</i>	5 cases
Multiple cysts in <i>osteomalacia</i>	6 cases

He states that in 7 out of the 12 cases in the first group, giant-cell tumors were noted, a further observation states that in the disease affecting the general skeleton, the cyst formations are apt to be smaller and the giant-cell areas more numerous and larger. So-called giant-cell tumors were also reported in the anatomic studies of cases diagnosed as *osteomalacia*.

Bloodgood expresses the view in his paper:

"There is no doubt that the bone cyst, *ostitis fibrosa*, and the giant-cell sarcoma may be a disease localized to one bone."

The writer regards the above changes, observed in bone lesions of this character, as different phases only, of the process of attempted repair following bone destruction. The initial cause of such destruction in the multiple groups is still a subject for further investigation and study.

The lesions described as giant-cell sarcoma and *ostitis fibrosa* in bone present a picture it seems impossible to disassociate from a regenerative process in connective tissue. The gross and histopathologic studies of the areas described as sarcomatous give all the criteria of structure we know to be granulation tissue (a primary effort in the process of repair and restoration). So-called *ostitis fibrosa* also gives the evidence proven

in other lesions, of a secondary reparative progressive stage, in which the granulations have become fibroblastic and a metaplasia from granulation into fibrous structure has taken place. It may be definitely stated that the masses of hemorrhagic structure with their giant-cell content, termed myeloid and giant-cell sarcoma, myeloma and hemorrhagic osteomyelitis, give all the known evidence that we possess of an effort at bone restoration.

Exactly the same sort of picture in both gross and microscopic studies may be observed in the reaction following fracture of a bone.

Bland Sutton made the statement several years ago:

"All who have studied histologically the exuberant material of repair around the seat of a fracture in a long bone, know the difficulty in deciding whether the new tissue is innocent or malignant."

He also expressed the opinion:

"I have come to the conclusion that some bone cysts in the long bones of children represent myelomas (so-called giant-cell sarcomas and giant-cell tumors) that have undergone spontaneous cure."

The writer advanced the same belief in a paper published in 1912.

The view frequently expressed, that the so-called giant-cell sarcoma (hemorrhagic osteomyelitis) has its origin in the multiple lesions, in areas of fibrous ostitis, does not seem to be well founded. It appears more reasonable to regard the vascular masses, encountered in these affections, as areas of ordinary granulation tissue, a primary structure, which has not progressed to fibrosis. The contrary view seems rather like "placing the cart before the horse." Nor is there any foundation for regarding such hemorrhagic structure as neoplastic. The presence of giant cells of the type observed in these tissues are certainly no criteria either of neoplasia or malignancy. As it is impossible to demonstrate either malignancy or neoplastic power in the type of giant cell found in the tissues of these so-called giant-cell sarcomata, there seems no reason to doubt that the hemorrhagic structure is just what its histology indicates—ordinary granulation tissue.

The presence of numerous giant cells in pathologic procession in bone, and especially in affections non-suppurative in character, has in the past been the real factor in ascribing malignant autonomous growth to such inflammatory lesions. In the light of present-day study and research, this view seems to have very largely lost ground, giant cells of the type prevalent in processes giving the picture of a vascular benign lesion being now generally regarded as having only scavenger or foreign body function. Mallory is very definite in his belief both as to their origin and function.

Elmslie reports in detail some of the cases from foreign literature recorded by Bloodgood and presents additional patients coming under his own observation. He also gives a list of references covering both the solitary and multiple lesions collected from American and foreign litera-

ture Elmslie's view that von Recklinghausen's grouping of all these lesions, under the term "malacias," is too broad, seems to be well taken. One cannot, however, accept his (Elmslie's) conclusions that diagnoses of the different type lesions may be made from the site in bone such lesions occupy.

Martelli reported a case in 1912 that evidently comes under the affections cited in this paper. The writer has been unable to obtain the article for study and comment.

Molineus published a critical study of three cases he had observed. They were all females, aged respectively seventy-four years, fifty-eight years, and forty-five years. The two older patients were married, the youngest was single. He regarded them as belonging to the group of malacias of von Recklinghausen. He noted a definite hyperplasia of the parathyroids in each of the cases. The multiple brown epulis sarcoma-like tumors occupying different areas in the bones, he did not regard as definite new growths, but considered them as masses of hyperplastic tissue brought about and being incident to the irritative and destructive processes present and occurring in the bones.

In analyzing the studies presented in foreign literature concerning these multiple pathologic processes in bone, one notes that many of the lesions contained within their lumen large areas conforming to what has been in the past regarded as sarcomatous neoplasia. The diagnoses in numerous instances, however, are grouped and rest upon such terms as multiple bone cysts, cysts in *ostitis fibrosa*, cysts in *ostitis deformans*, and cysts in *osteomalacia*. The so-called giant-cell sarcoma content has apparently not been regarded of sufficient consequence, importance, or value to place such lesions definitely among the neoplasms of bone. While it must be recognized that the solitary local process and the multiple systemic lesions give exactly similar gross and microscopic pathologic findings, it also seems quite clear that the etiologic factors bringing about these identical appearing conditions are varied. In a great majority of the solitary lesions the etiologic factor in their production seems to have been bone trauma. This factor obviously cannot account for the multiple processes. von Recklinghausen regarded the systemic multiple lesions as being due to and an exhibition of different forms of "malacia."

In recent times observers and investigators incline to the view that the multiple processes have their origin in endocrinal glandular disturbance and faulty nutrition, such conditions causing lack or loss of equilibrium in the chemistry of bone balance, others suggest they are the result of systemic bacterial infections. The rôle the spirochæte or tuberculous bacillus may play has not been demonstrated. Where Wassermanns have been taken, negative results have always been reported.

Of paramount importance are the pictures these lesions present at operative intervention, equally so are the gross and microscopic patho-

logic studies. Particularly important is the phase of the process that exhibits the highly vascular tissue masses, generally mistakenly regarded as myeloid or giant-cell sarcoma.

Ziegler's description of granulation tissue conforms in every respect to the structure under consideration.

He states

"The inflammatory proliferation of tissue is essentially a regenerative process which has for its aim the compensation of the tissue lesions produced by the causes of inflammation. Under especial conditions, it leads not infrequently to a hyperplastic proliferation of connective tissue, frustrates its own aim and causes new damage. This is particularly the case when, as the result of the persistence of the cause of the inflammation in the organism, there is kept up a permanent condition of inflammation."

He further states

"The granulation tissue which forms in the course of an inflammation is nothing more than an embryonal tissue arising through cell proliferation and infiltrated leucocytes. Primarily it consists of cells and newly formed vessels. The young embryonal tissue is richly supplied with blood-vessels which give to it its red appearance."

He also notes the presence of giant cells with the other cells composing these granulation tissue masses.

The many studies and descriptions of regenerative inflammatory processes recorded by early and modern investigators, from the time of Cohnheim, Burdon Sanderson, Green, and Ziegler to present-day students of the subject, including Francis Carter Wood, Adam, Mallory, Ewing, and others, are all in accord in their views and presentations of pictures describing inflammation and regenerative granulation tissue proliferation. The descriptions thus presented correspond in all particulars to the pathology of the so-called medullary giant-cell sarcoma.

Experimental studies give evidence that one may without difficulty produce these mistakenly termed neoplastic processes at will, by following the technic suggested by Barrie.

Ribbert's latest conclusions state "A tumor cannot be produced experimentally without existing predisposition thereto."

Under the title "Benign Giant-cell Sarcoma, Epulis Type," Ewing states as follows

"As the spindle cells of the stroma become more active and abundant, the giant cells diminish, the tumor shows less resemblance to granulation tissue, but becomes firmer and like spindle-cell sarcoma."

This statement is illuminating in that Ewing describes changes taking place in the granulation tissue mass, that later gives the appearance of spindle-cell sarcoma. A change from inflammatory into neoplastic tissue.

One must, of course, recognize the potentialities for neoplastic growth in any chronic process, particularly in primitive tissue. It, therefore, should not be unexpected if in these conditions there is occasionally en-

countered a lesion undergoing degenerative malignant proliferative change, such malignant transformation, however, must be infrequent in the processes under consideration

The writer has personally observed 35 cases of the solitary affection, only one of which has given any evidence of neoplastic change

A colleague made a diagnosis of hemorrhagic osteomyelitis at operation from the appearance of a focus in the lower end of the radius in a patient aged thirty-one years. The tissue removed was a reddish-brown colored liver-like substance. The opportunity was given the writer of seeing the X-ray in this case, taken before operation, who had no hesitancy in regarding the process revealed as a true medullary sarcoma. This diagnosis was confirmed on later examination of the microscopic section, the latter exhibiting the typical appearance of a fibrosarcoma within which neoplastic structure, very numerous giant cells of the scavenger type were observed. The gross pathology in this case would lead one to regard the sarcoma as probably having arisen in granulation tissue. In sarcomatous processes, so well pointed out by Mallory, it is the stroma that presents malignant degenerative proliferation, not the osteoclasts or scavenger giant cells.

From our studies and reading of the literature covering the subject, we have reason to believe that occasionally, though rarely, processes exhibiting vascular granulation tissue masses in bone, particularly where the areas are of large size, may take on degenerative proliferative malignant change, by transformation of primitive granulation into neoplastic structure (usually fibrous in character). Such change always shows an increase of tissue beyond normal efforts, bounds, or control, with absolute evasion of regular structural architectural cellular arrangement. It is our contention, however, that one is not justified in regarding these hemorrhagic granulation tissue processes as neoplastic until neoplasia is proved, it is our further belief that malignant degenerative change in such cases is exceedingly rare.

Butlin's studies published forty years ago are still quoted frequently regarding the diagnosis of these lesions. He apparently based a diagnosis of sarcoma in these vascular processes on their giant-cell content alone. He believed that as much as four-fifths of the bulk of a mass might be composed of giant cells and also ascribed the maroon red color of the lesions as being due to the presence of such cells. In our experience both contentions seem incorrect.

A definite diagnosis of multiple hemorrhagic foci in bone (hemorrhagic osteomyelitis) in the present state of our knowledge is only possible through operative intervention. As a diagnostic aid the use of the X-ray is essential in exposing areas of osteolysis caused by injurious agents. One is frequently unable, however, to differentiate from the radiograms alone, between multiple myelomata, multiple gummata, multiple hemorrhagic osteomyelitis and perhaps metastatic carcinomata of bone.

The clinical data obtained from tests made of blood, serum and urine, together with the gross physical appearance of lesions observed upon clinical examination, are in some instances sufficient to reach diagnostic

conclusions, but final diagnosis rests upon gross and microscopic pathologic findings. Neither multiple myelomata nor the metastatic carcinomata give the picture of granulation tissue and giant scavenger cell content obtained in multiple hemorrhagic osteomyelitis.

Treatment of the multiple lesions, until recent years, does not appear to have received much attention. Curetting, as practiced by Kanavel and Haussling and Martland, appears to have been beneficial and should be recommended where lesions are localized and readily reached. The writer would urge further efforts in attempts at the discovery and removal of the constitutional cause or causes, whatever they may be. McCrudden's chemico-pathologic studies regarding the etiology of osteomalacia open up a field in this direction, as do also the work and studies of those interested in endocrinal glandular phenomena.

Ewing is very enthusiastic as to the value of radium as a therapeutic agent in all lesions of this character.

In our case, Coley's toxin was given under the latter's direction for several weeks.

The feeling of the writer at the present time regarding therapeutic measures in cases exhibiting the multiple processes is that where lesions are accessible for curetting, such should be performed, where inaccessible for surgical procedure, radium may be tried, or Coley's toxins used. Perhaps more important than anything else in the treatment of cases of bone disturbance of this character will be methods having for their object the restoration of nutritional lime-salt equilibrium. These bone conditions are exceedingly chronic and insidious in their onset, that they, in fact, shorten life, does not seem to have been demonstrated.

CONCLUSIONS

- 1 Hemorrhagic foci in bone (hemorrhagic osteomyelitis) should not be considered as neoplasia, producing bone destruction, but rather as regenerative granulation tissue masses whose end effort is restoration of areas already destroyed by some injurious agent.

- 2 The etiologic or exciting factors in destruction observed in the multiple processes are not yet fully determined. Endocrinal glandular disturbance, poor lime-salt nutrition, the spirochæte, and other bacterial infections seem to partake in the etiology of such lesions.

- 3 The solitary lesions presenting a similar gross and microscopic pathologic picture, in a great majority of instances, give a history of bone trauma.

- 4 The affections responsible for the production of processes of the multiple type are low-grade chronic systemic diseases that apparently do not definitely shorten the life of the individual to any demonstrable degree. The cases noted in literature have all given histories of many years' duration.

5 The arrest of repair in which the granulation tissue remains as such without progressive metaplastic change into fibrosis, or the end product bone, is apparently partly due to insufficient formation of fibrogen, thus preventing chemotactic balance

6 These lesions, because of their primitive structure, may be regarded as possessing potentialities for neoplastic change, but malignant transformation must be very rare, when such does occur, the scavenger giant cells apparently take no part and are frequently greatly lessened in number

7 That lesions of this character should be regarded as low-grade inflammatory reparative processes and classified accordingly among the regenerative inflammations in bone

8 Delay or arrest of repair in these processes, as evidenced by the continuous presence of highly vascular structure, seems to be due to a lack of chemotactic balance, local or general

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COMPRESSION FRACTURES OF THE LOWER END OF THE RADIUS

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THE laws applying to the mechanics of materials apply to fractures in bone as regards stresses or strains just as they do to other substances which have been tested experimentally to determine the breaking strain. They conform closely in their type to fractures in wooden beams which are possessed of fibre structure, because bone is made up of fibre material with various salts of calcium, potassium, magnesium, and iron. It is not entirely granular like iron or steel.

A study of elementary applied mechanics would be of advantage to most surgeons.

1 Compression stress is the driving together under compression of the molecular structure up to the breaking moment, and then the sudden collapse of the entire fibre structure of the substance. There is little slivering, the fibres simply go to pieces in fibre structures, and in steel or iron or granular substances it may break into wedges or fly into small pieces like an explosion, as it does in granite. The structure itself has disintegrated.

2 Tension stress. The molecular structure or fibre is pulled apart, there is no collapse of the structure, or if granular like steel, there is no tendency to fly into pieces. There are many lines and fissures usually, and one deeper crack which widens more or less transversal, but there is usually slivering in fibre structures and the fibre structure is not disintegrated, it is simply pulled apart on the tension side of a transverse break.

3 Torsion stress is twisting stress and follows pretty definite rules applying to stresses and strains. There is also the slip in fibre structure, a compression on one side, and a tension on the other, and the tendency to split longitudinally the whole length of the structure, a separation through the neutral axis. This does not usually apply to bone. There are, however, to be taken into consideration the sheering stresses where one material is sheered off by the more or less sharp edge of a substance, one or both substances being under compression. These are about all the forms of stresses and strains with which we have to deal as surgeons.

Since writing this article I have read a paper by Speed who has dealt with this subject in a very able manner, although I think he has fallen into the error of most of us of attributing too much importance to the tensile character of fracture in bone.

If you break a dried stick by bending, you impose two strains, a compression on the side of concavity and tension on the side of convexity. The stick begins to part always on the side of convexity, a

tension fracture, the molecular arrangement of the substance is pulled apart. It seldom or never breaks on the side of compression at the breaking moment. Compression and tension are equal as they are always equal in these transverse breaks. These fractures are not always, however, analogous to fracture in bone, and that is the point where many of us myself included, have been making mistakes, because as medical men we seldom have time or inclination to dig deeply into other branches.

If you will examine closely Fig. 1 you will get a pretty definite idea of a tension fracture in fibre structure. But it has been found experimentally that when we use comparatively short lengths of green fibre

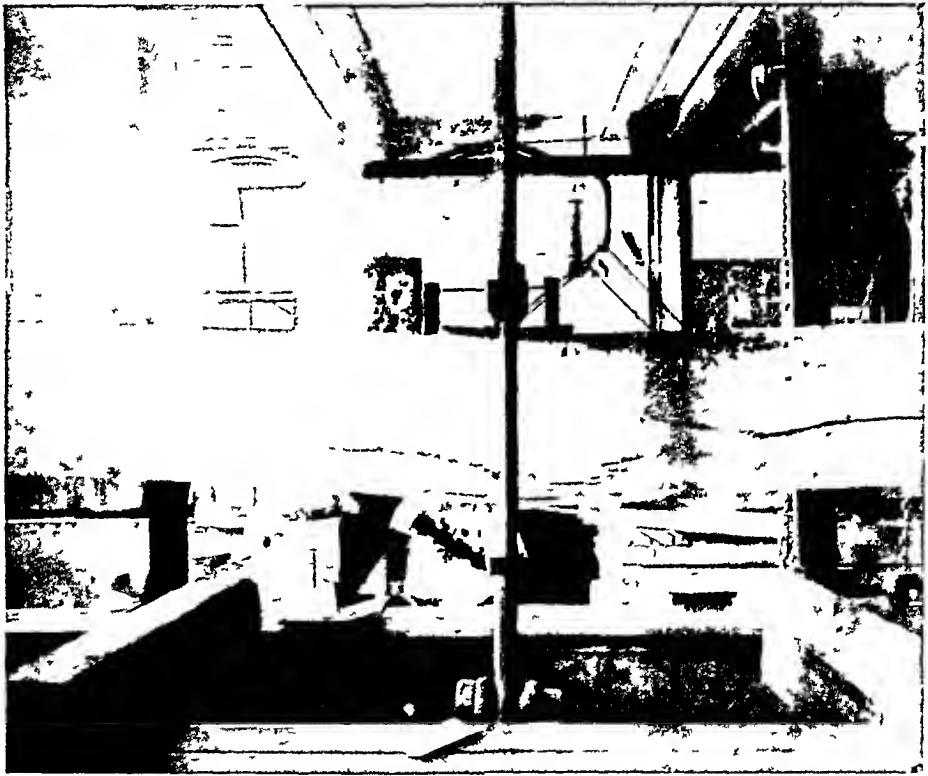


FIG. 1.—Tension break in fibre material. Note splintering on tensile side. No destruction of fibre.

material and apply axial compression in the testing machine we get no such break. Instead of a tension fracture, we get in nearly every instance at the breaking moment an entirely different complex, a compression fracture, the whole fibre structure on the concave side, the compression side, simply lets go and goes absolutely to pieces. There is no splintering, there is no driving together of wedges and splinters of material, telescoping, impaction, the structure simply disintegrates and loses all cohesion. This is a compression fracture.

For the purposes of this article, a discussion of the mechanics and treatment of those fractures of the lower end of the radius which have been called Colles for so many years and which we contend should be called compression fractures of the lower end of the radius, because that

terminology would instantly visualize the mechanics of the injury, and to refute, as we believe we can, the idea which is universal, that there is a great amount of impaction in these fractures, it is necessary that we have this clear idea of the difference between tension and compression breaks, and if we have this, we shall be able to see and appreciate as we look at Fig 2 exactly what has happened to this great beam tested in the machine at the Massachusetts Institute of Technology, showing a typical compression break with actual disintegration of the entire fibre structure on the side of compression, and shall thus be able to apply it to our problem. Glance at Figs 3-9 and 10, X-ray plates of Colles' fractures with what we

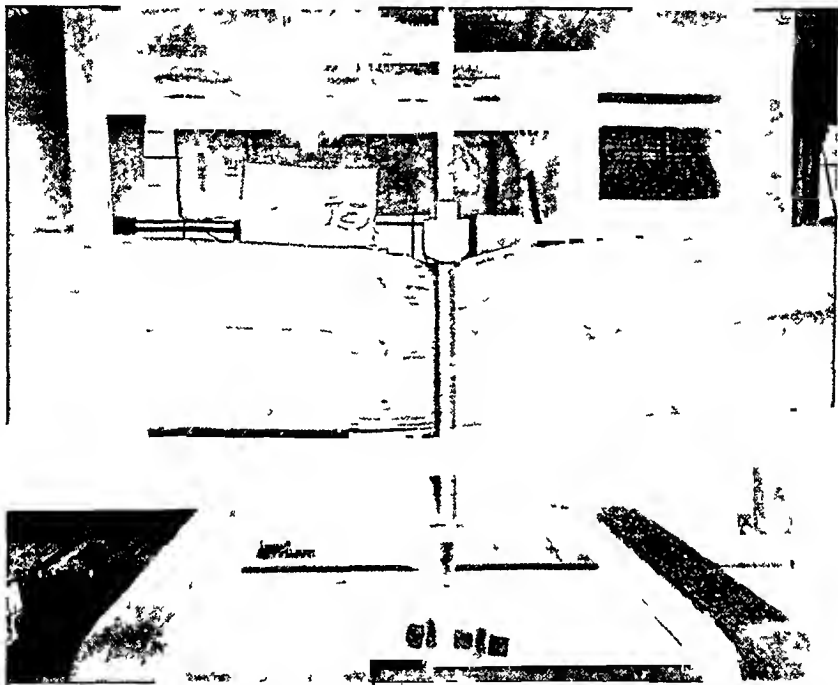


FIG 2 —Compression fracture in fibre material. Note collapse of structure on compression side. Is this not a typical Colles fracture with so called impaction?

have been pleased to call impaction, and you will observe the great similarity which they show to this beam broken under compression. They show typical impaction in this type of fracture, yet there is no impaction, as proved by the reduction and the mobility under local pressure. Neither is there any impaction in any Colles' fracture, since by impaction we mean telescoping, and that would mean rigidity in all cases showing this type of deformity. Instead there is actual disintegration and loss of substance just as there is here. The fibre structure has been crushed, disintegrated more or less, and there is nothing to impact.

Call it crush, if you wish, and you will be correct, but do not call it impaction. This is proven because after reduction these cases will still show the same change. If impaction occurs it is obvious that the frag-

ment cannot be dislocated backward or in any other direction. There may be a different set to the planes of the articulation, but there can be no greatly dislocated fragment. There might also be impaction after dislocation, but it would be more impingement than impaction. In order to reduce these it would have to be broken up, but it would not show to any great extent after reduction, since it would not then be impacted. Take your X-rays of bad cases after reduction and you will see that what the X-ray men and the surgeons call impaction still remains, but you will know that, since the fragments move easily, there can certainly be no impaction. There still remains the antero-posterior change of plane in the articulation, due to the compression with its loss of fibre structure and a certain amount of this loss is always permanent. The mechanics of these fractures has been for years a debatable subject, attachment, sheer,

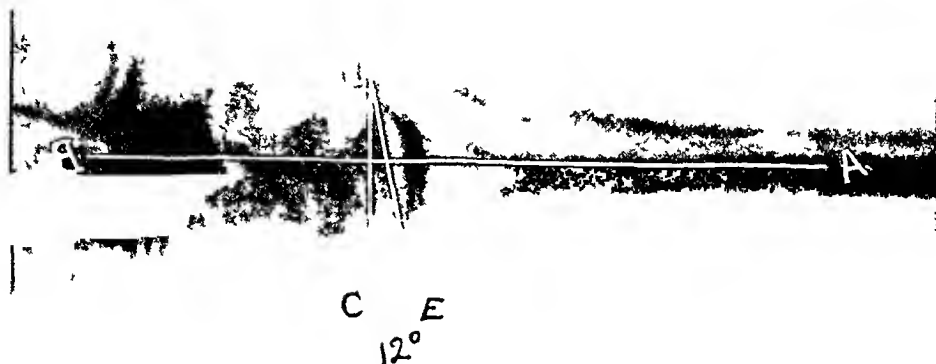


FIG 3—Showing reversal of angle (so-called impaction). Some of this may be corrected but never all of it except at risk of a stiffer joint than if it had not been touched. There will be anterior prominence of the wrist in this case unless corrected.

flexion, have all been discussed, and at present it seems to be pretty generally agreed to attribute them to the weaker structure of the flare of the radius at the lower end and let it go at that.

Is Colles' fracture a compression fracture? If it is, then there is no impaction. The general conception is that it is a tension fracture, the break beginning on the anterior surface of the wrist, radius, extending to the back exactly as a dry stick breaks. The man who suffers a Colles' receives it in one way, and one way only.

One writer has said that he has seen a typical Colles' fracture caused by falling on the back of his hand. This is an impossibility and no one ever saw such an injury. The patient slips, throws out his hand to save himself, his hand in pronation, and comes down upon his palm, the hand is forced backward, and the point of resistance falls upon his thenar and hypothenar eminence, the first line of carpal bones, and is transmitted to the radius. If you look at these bones and place them in this position,

you will find that they conform to the arch of a bridge with the semilunar as the keystone of the arch, the semilunar being wedged into the articular surface of the radius, and in this position of pronation the line of resistance will fall nearer the posterior surface of the radius than the anterior. These bones are locked in this position, the elbow is locked also by muscular and ligamentous action, and we have converted the arm and hand into a strut, which at the moment of striking becomes for all practical purposes a column, with a small inclination to be sure, but

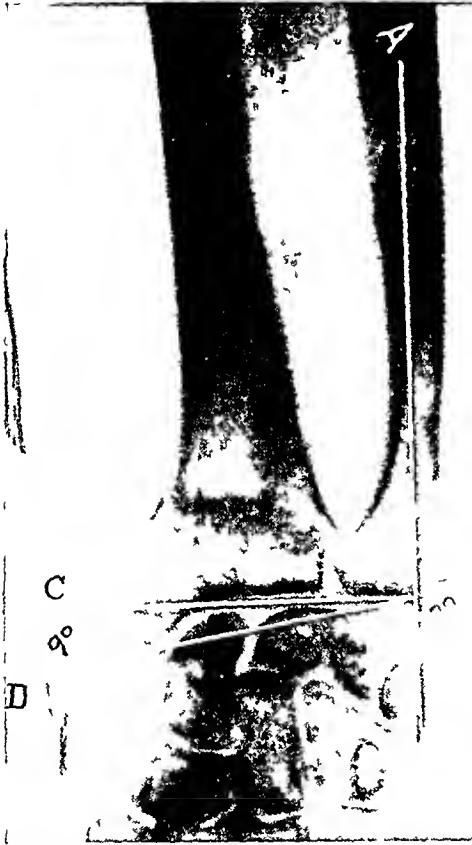


FIG 4—Shows change in the lateral plane

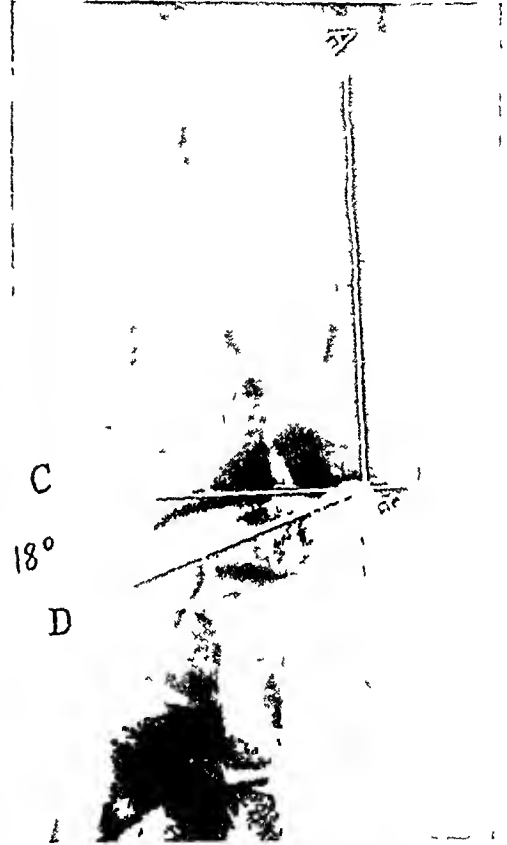


FIG 5—Case IV Lateral view—little disturbance of angle C B D Antero posterior view showed how ever, reversal of the angle

pretty nearly prependicular, weight above and the resistance below, and the laws applying to stress in struts and columns apply here

There are many ways of applying power. By means of the three types of levers and by means of a movable strut, one end of which is fixed firmly and the other moves. This is a powerful way of applying force and is really a lever with one arm gone. It is the principle used in all stone-crushing machines.

The position of the arm in this injury is much the same as the position in injuries to the upper end of the humerus. (See "Fractures of the Upper End of the Humerus," ANNALS OF SURGERY, 1918) Both fall with

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hand in pronation, but the similarity ends there. If the hand and arm are widely extended from the body plane, the moment the hand touches the ground, we get a tremendous lever action, and later on, as the body falls, we get a fulcrum on the acromion process, and a fracture of the upper end of the humerus results.

The difference in Colles is simply one of position. The arm is not widely extended from the body. It is comparatively near the body, and when the hand strikes the ground we have no great amount of leverage. We have a strut action, both ends of the strut more or less rigidly held,



FIG. 6.—Case IV. Motion on tenth day of a Colles.

in reality a column, the weight of the body falling more nearly perpendicular upon the end of the strut or column. It is either straight or bent at the elbow more or less, but held rigidly by muscle action.

In other words, we have really a pile-driver action, the static load of the weight of the man (and pretty nearly his entire weight) coming down upon one end of a column. We have the tremendous increase in stress over the static load due to impact, the weight of the man falling through several feet and landing upon a rigid or comparatively rigid column. It is obviously impossible to estimate this stress in pounds per square inch, because there are so many factors to take into consideration. Some of the force is taken up by the give at the elbow. Some of it is dissipated by the elasticity of the strut or column. Some of it is lost by

the character of the substance upon which he falls, but for purposes of illustration it is a comparatively simple matter to show how tremendously in excess of the strength of the radius such a force would be, and also to determine the comparative ratio of compression to tensile stress. The amount of pounds per square inch are of no importance, since they are enough to smash the bone, but it is of importance to know the comparative stress in compression and tension.

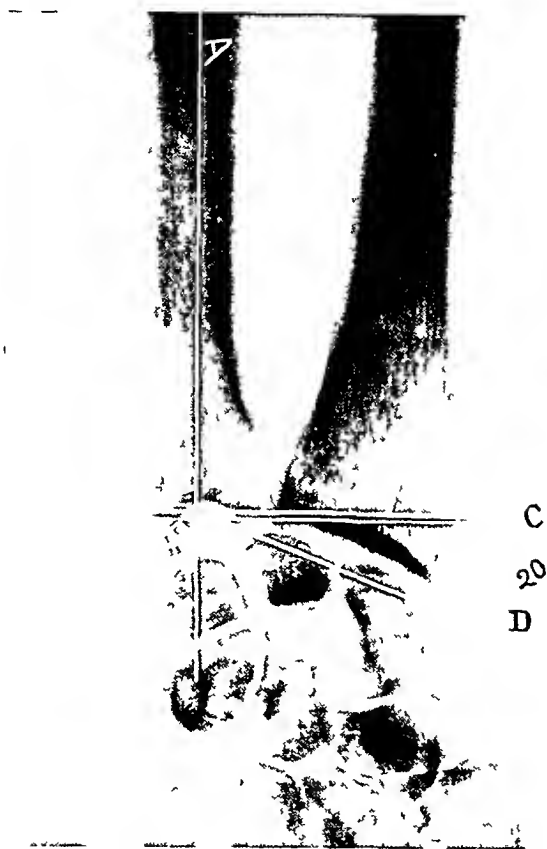


FIG 7—Normal lateral plane. Angle C B D usually between 14° and 20°

AB Fig 17 represents the line of gravity of the load or the neutral centre of the strut, the load in this case being the weight of the man falling through the line of this movable strut AB and striking at B upon the ground. At the instant of striking there is the force of resistance acting along the line CD, in the direction of the arrow, to force the point B upward in the direction of CD, and this we call the bending force. This is what the mechanical engineer terms the line of resistance, and there would be a transverse breaking strain added to the compression force upon the axis of the strut due to the weight of the man falling, and where the lines of these two forces, the resultant acts greatest upon the surface of cortical bone would be the breaking point. There are several reasons, which we shall consider later, why this would probably be the lower end of the radius, but for the present let us consider the compression force alone, along the axis of the strut due to the weight of the man.

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If the movable strut AB, the arm, were rigid and exactly perpendicular, the line of resistance would coincide with the line of gravity, AB, which is also the neutral axis as regards a bending force, and we should not be able to say where the bone would break, after the crushing force, the load, became too great for the strut to bear. But in this case the line of resistance is not the same as the line of gravity, it is the line CD, and somewhere along this line where these two forces act as bending strain, with greatest intensity, will be the point of great com-

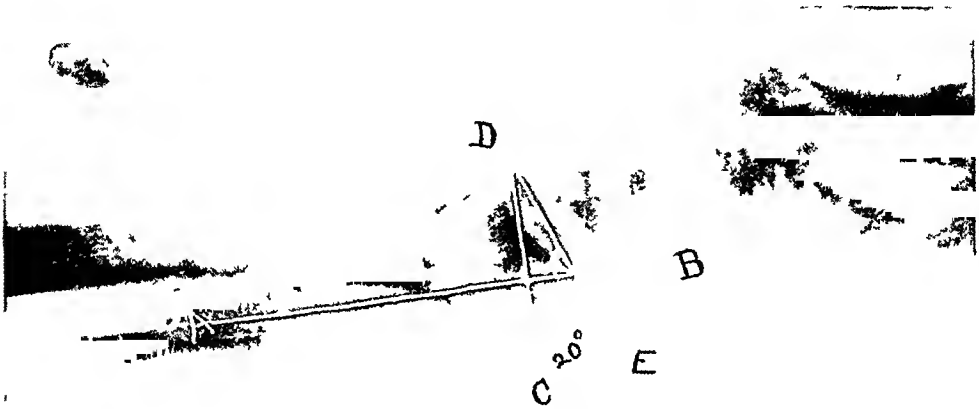


FIG 8—Showing normal angle, antero-posterior plane Line DE is always in front of line DC
Angle CDE seldom less than 10° or more than 20° Angle is often reversed in serious cases

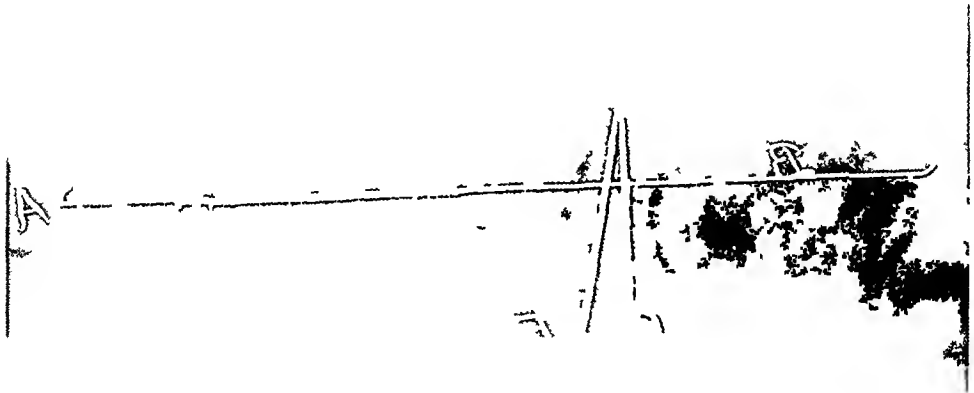


FIG 9—Antero posterior reversal of the angle CDE

pression, and this is where the radius would break. So exactly opposite will be the point of greatest tension and the radius breaks across EF. The bone may be weaker here as some claim, but weaker or stronger, this is the point of stress, and this is where every radius subjected to this strain will break.

A factor which the mechanical engineer always takes into consideration in computing stresses or strains, is what he calls eccentricity of load that is where the line of resistance does not correspond to the centre of gravity of his strut, and if you will glance at Fig 17, you will find that the line DC, resistance, does not correspond with the line of load which is also the line of gravity AB. If we

draw the line GH, from the line of resistance CD, to the line of gravity AB, perpendicular to AB, we have what is known as the lever of eccentricity, and, with this known, we can compute the strain or stress upon our strut, and it is our

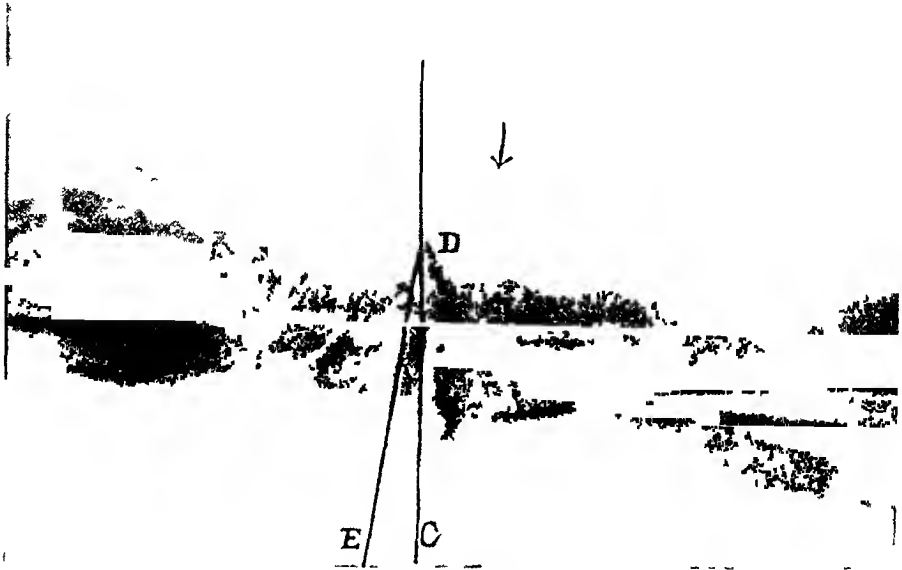


FIG 10—Case II Not true antero posterior as it should be angle CDE is in front of CD Therefore little change



FIG 11—Shows motion active on second day of Type I case Shows dressing after second day in these simple cases Same dressing in more serious cases from fifth or sixth day to the ninth or tenth day Only dressing after tenth day shown in Fig 12

contention that this eccentricity of load is more a factor in fracture of this type than the straight compression due to the weight of the man falling on his hand, because it accentuates the compression already existing on the compressed

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side at the expense of the tension which exists upon the other side, in other words, compression is greater than tension. If compression were equal to tension, which is a fact in a simple transverse strain, then it might break in tension as well as compression. Here we have an actual compression, tending to bend the strut, the radius. Is compression greater than tension? Let us see.

Let I represent the area of bone section at the joint of break, $\frac{\text{LOAD}}{I}$ equals stress in compression per square inch of section at I , the point of fracture.



FIG 12 —Case I. Shows motion—two exposure plate on tenth day. Restriction here shown is due to our wrist strap. Note ulnar cut out.



FIG 13 —Case II. Shows motion on tenth day.

Suppose the area at I to be a rectangle, it is pretty nearly that any way, with a length of $1\frac{1}{2}$ inches and a breadth of $\frac{1}{2}$ inch. Let us assume that the dead load, *i.e.*, the weight of the falling body, to be one hundred pounds. In a heavy man it would easily be that or more, since in this type of fracture the man actually sits down with his full weight upon his hand supported by a rigid forearm. The formula for determining this would be $100 - 15 \times 5 = 133$ pounds. So that the dead compression on this cross section of bone under these conditions, which are of course simply explanatory, but still somewhat near the truth, would be 133 pounds per square inch of surface. Not such a tremendous force. But there are other factors which come into this problem. The force is not transmitted in the direct centre of gravity, *i.e.*, the neutral axis. With the hand in pronation line of resistance is decidedly

nearer the posterior or upper edge of the bone, and the force of this resistance would not fall in the same line as the neutral line it would fall in the line CD. This, as we have said, is called the eccentricity of load. The line HG is what is called the lever of eccentricity so that after all we have a certain amount of leverage in these breaks. Were this line of resistance exactly along the line of the centre of gravity, we should have no increase in compression over the 133 pounds



FIG 14 —Case III After reduction shows some disturbance of the antero posterior plane remaining



FIG 15 —Case III Double exposure plate to show motion on twelfth day of fracture. Compression fracture of the radius should show ability to approximate a right angle in flexion and at least 45° in extension not later than the twentieth day. Most of them will do this earlier

of dead compression, up to the bending moment. The bending moment which is represented by load multiplied by HG, the lever of eccentricity, is resisted on the posterior side, top side with hand in pronation, by compression, and on the anterior side, the side nearer the floor in the case of a man falling upon his hand, by tension, the compression being greatest at the upper edge and the tension being greatest at the lower edge of the bone. This tension of the lower edge is partly offset, we must remember, by the compression due to dead load, which operates here as elsewhere, and therefore, with these facts clearly in mind, let us see what happens at the bending moment.

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This extra compression at H due to eccentricity of load can be reckoned as soon as the section is known. Let us for the purpose of illustration call the section as before

In Fig 17, L being the width and K the length of the rectangle, L being $\frac{1}{2}$ inch and K being $1\frac{1}{2}$ inches, and let us call the lever of eccentricity, HG, $\frac{2}{10}$ of an inch. The formula, would then be load multiplied by HG, the lever of eccentricity $= \frac{F \times K \times L}{6}$ in which F is the outside fibre strain, cortical strain, and is greater the greater the distance from the neutral axis. Same problem as before, load 100 pounds, section of bone at the breaking point $1\frac{1}{2}$ by $\frac{1}{2}$ inch, eccentricity $\frac{2}{10}$ of an inch. Additional compression due to eccentricity $100 \times 2 = \frac{F \times 1.5 \times .5 \times 5}{6}$ F equals 320 pounds per square inch. Total compression then on the upper side of the bone 133 pounds plus 320 lbs equals 453 pounds per square inch. On the lower side of the bone the tension



FIG 16 —Showing how little the deformity even with reversal of the angle perfectly flexible wrist. Picture thirty-fifth day so that there is still some of the temporary swelling remaining. Used hand for all purposes after fourteenth day. See Fig 9 for X-ray.

is equal to the compression due to eccentricity or 320 pounds of tension, but from this must be deducted 133 pounds of dead compression, leaving 187 pounds of tension stress on the under or anterior side of this bone. Compression is greater than tension, therefore, it is a compression fracture, and, therefore, if it is a compression fracture there is no impaction. Nor is this all, for a short column centrally loaded, the compression stress in pounds per square inch equals the crushing weight in pounds divided by the area in square inches, but for a long column which tends to bend under load, the stress on the concave side is greater and on the convex side less than the crushing force divided by the area in square inches. This stress is distributed over the section only when the resultant passes through the centre of gravity. Any deviation from such a centre will bring the maximum unit of stress to one edge and a minimum to the other. We have dealt so far with straight compression, but we must take into account also stresses produced by suddenly applied force, shocks, impact, and these we know are very much greater than dead compression.

Now let us add this also. Merriman, "Mechanics of Material," tenth edition, says that the exact determination of actual stresses in a case of axial impact is impossible by theory where the elastic limit of the material is exceeded. The problem is too complicated, but in our case it is not necessary to know the stress exactly in pounds per square inch. We should have to know the resistance of the material (radius) and the compression produced, and many other factors, but

it is enough for our purposes to know that the stresses produced are tremendously greater than the static load Merriman, page 327, tenth edition, cites an example of a stress produced by a load of 60 pounds, moving at a velocity of 10 ft

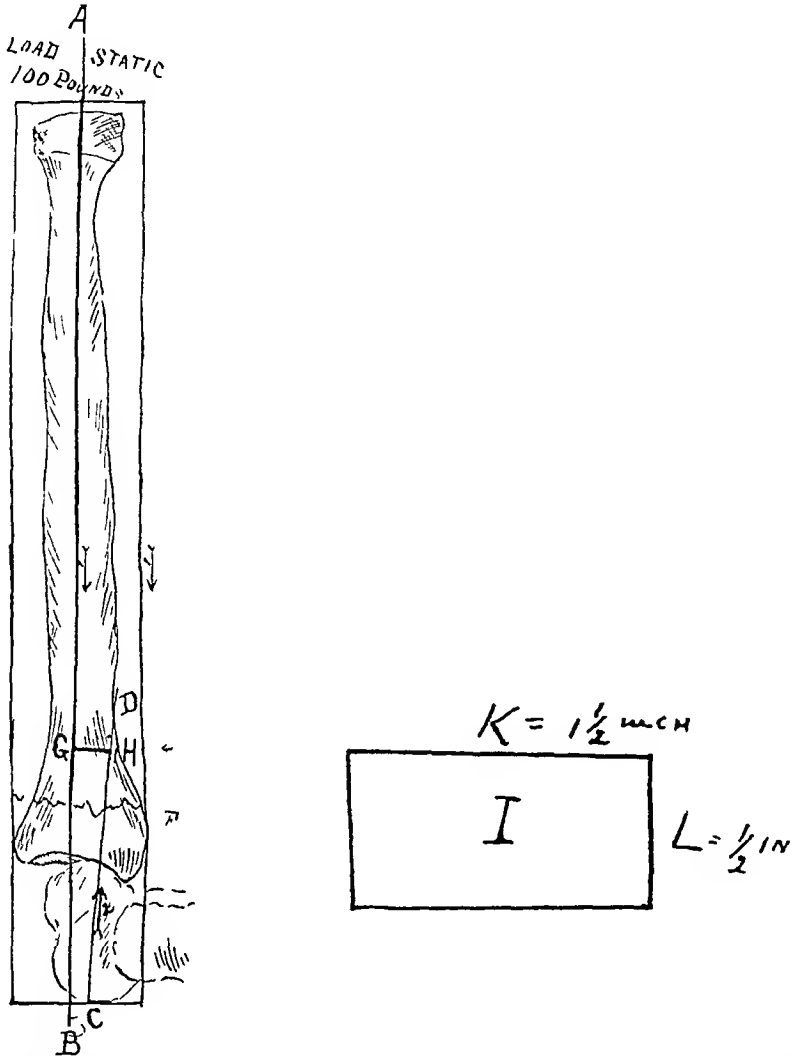


FIG. 17—A B strut B being the immovable end of the strut friction on the floor or ground fixes this end firmly Should it be very slippery and not hold he will not break his wrist It is conceivable that under these conditions he may break his shoulder as I have shown in another article (see Fracture of the Upper End of the Humerus ANNALS OF SURGERY, 1918) but he will not break his wrist I, rectangle representing lower section of radius, K 1 5 inches for purposes of computation, L, 5 inch

NOTE—In Fig 17 and in this article we speak of the centre of gravity of the column Were the column perpendicular the centre of gravity and the centre of compression would be the same and they would also be the neutral axis In our case, however, the column is inclined and the centre of gravity would in reality not be the same, as the centre of compression or the neutral axis In using the terms "centre of gravity" in our case it is understood that it is the centre of compression which we mean and not the exact centre of gravity which is the term that the mechanical engineer uses in estimating stresses on a perpendicular column The centre of compression in this case as in the perpendicular is of course also the neutral axis

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per second and producing 510 times as great a stress as was produced by the same load as static load. Now, we know, if our man fell from a height of 3 feet without resistance, he would be falling at the end of the 3-foot fall at about 14 feet per second. Imagine what the force of the blow would be expended on our radius of $1\frac{1}{2}$ by $\frac{1}{2}$ inches. And remember that no matter what the blow would be it would act eccentrically exactly as the static load acted, and the compression force would be increased always over the tension, in the same proportion which we have already shown as static load. Multiplying our figures by 10 even, and the result would be 4530 pounds per square inch of compression against 1870 pounds of tension.

So that, apparently, in the case of a man falling upon his hand, and therefore offering the resistance of friction to the sliding, we have added the increased stress of a sudden blow which is immensely greater. We have also in this case the eccentricity of load, due to the line of resistance not passing through the neutral axis of the strut, thus increasing the compression force on the side of compression and diminishing it proportionately on the side of tension.

We have the bending force, since the strut in this case is long in comparison with its area in square inches in section, and we have the molecular inertia of material in the presence of a blow greater than its compressive or tensile strength, this blow falling on the lower end of the strut, the radius.

We know it breaks at this point, which therefore must be the resultant of the breaking stresses which have been brought to bear upon the bone. Why should it always break at identically the same point? As a matter of fact, it probably would not save for two factors, velocity of stress and inertia of the material. Our strut is more or less fixed at both ends and resists motion, as we have said.

Now velocity of stress is exactly the same as velocity in anything else, depending upon a great many factors, of course, and where this stress or strain is markedly out of proportion to the strength of the strut, the first section of the strut receiving this impact would be unable to transmit it along the whole strut, therefore, the section first subjected to strain would be the part to break, in our case the lower end of the radius. We must also take into account the molecular inertia of material, and here again, where the strain is so much greater than the strength of the strut, the tendency would be to break at or near the first contact and this again would be in our case the lower expanded end of the radius.

We may add to this, if we wish, a point which has always been claimed but never proved, that the lower expanded end of the radius is the weakest part of the bone. That is still *subjudice*. The main point of all this, which may seem to some needless, is that the bone breaks in compression and not in flexion, primarily, and that if this be so, we get an entirely different kind of a break as regards the fibre structure, a compression break on the posterior side of the bone, just above the wrist-joint, always at or near the same point, and a tension continuation across

the anterior surface It does not fissure behind, it may or may not fissure in front

In certain cases we may have an added torsional stress, at the same moment The difference of deformity, even of the plane of break, will depend upon the relations of the radius to the blow struck Should the hand be flat in pronation the break is directly above the joint and the distal fragment goes backward into posterior angularity, tilt If the blow falls upon the ulnar side of the hand the direction of the line of resistance is again different, there is a different area of compression, and on breaking the distal fragment is abducted and posteriorly displaced as well, but the abduction deformity is greatest The normal planes of the joint are changed, not due to impaction, as has been claimed, but due to actual compressive destruction of cortical bone, and this is the reason why these planes can not be entirely replaced in their normal relations This change may be little or it may be great, but it is always there, and it remains under any form of replacement By weight extension and fixation until new bone filled the gap it might be corrected, but it would be by holding it in position for a long period of time, and the result so far as motion is concerned would be far more apt to be unsatisfactory After all, the great desideratum is a freely movable joint at the wrist

The eye is fallible even in judging an X-ray plate and the main point to determine is the change of plane both antero-posteriorly and laterally in these compression fractures, because an anatomical replacement, as far as possible, is to be desired, especially in an area which is so crowded with important structures

A two-way X-ray in these cases, exact antero-posterior and exact lateral, is a necessity, but it is usually not possible to have these taken until after reduction In hospital cases this can be done, as it does not entail any great degree of lost time, but the rule reduce at once, is by far the better rule The sooner the reduction the less reaction to injury The stereoscopic view is of little use in this type of fracture A stereoscope is valuable to show rotation, and no rotation or very little is possible in the ordinary Colles Some writers speak of rotation of the fragment Rotation of a long bone is a twist upon its long axis and a twist upon its long axis is an impossibility in an ordinary Colles What these writers mean is backward displacement The X-ray tells us two things which are important Are the two planes of the wrist-joint, lateral and antero-posterior, restored so as to approximate normal? It is difficult to measure this with absolute certainty, because there is no fixed point from which to start that under all conditions and positions of the hand remains the same Obviously it could not be measured in centimetres, the distance from the tube at which the X-ray was taken, the difference in the size of the bones in different cases, would render worthless any such scheme of measurement We have depended upon angles and these must of necessity vary widely, but we think that they approximate closely enough, so

FRACTURES OF THE LOWER END OF THE RADIUS

that we are able to get a fair idea. If the lateral plane is not restored it is quite obvious that the entire hand will be thrown toward the thumb side abducted the ulna will be unduly prominent, and if the antero-posterior plane is not restored it is equally obvious that a certain amount of backward displacement of the hand will remain and the anterior curve of the wrist will be exaggerated. The ulna is usually not broken. Draw a line as nearly in the longitudinal centre as possible. It will never be exactly the same, but for practical purposes it will answer (see A B, Figs 4 5 and 7)

At its lower end, where it cuts the lower surface of the ulna, erect a perpendicular to AB. It will cut through the enlargement of the lower end of the radius. Do not measure from the ulnar styloid, it is too often broken. BC is this line. From B draw a line to the lower inner side of the radial styloid, BD. In a great majority this angle will be found to be between 14 and 20 degrees and it will not vary greatly from this. Should there be much change in the plane of the articular surface it will show in the reading of this angle, and with this help it will be much easier to predict the subsequent amount of deviation. The nearer the line DB comes to CB the greater change in the lateral plane of the joint and the smaller the angle. It is better to be forearmed and to have a definite idea of what is coming in the way of permanent deformity than to have the patient discover this later for himself. A thing explained beforehand and understood by the patient may save a lot of trouble later. It is better to have good function than good looks where one has to be sacrificed for the other.

Usually it will be possible to conserve both but where there is any question sacrifice looks always to function. Of even greater importance will be the measurement of the antero-posterior plane of the joint surface. This must be a true lateral view, without distortion. Draw a line straight down the centre of the radius, ignoring the broken end, AB (Fig 8). Join this line by another perpendicular to AB just touching the anterior inferior surface of the radius CD. Draw the line DE from D just touching the posterior extremity of the radius at E. The angle CDE will nearly always be an angle of between 10 and 20 degrees. It will rarely be less than ten and equally rarely more than 20 but the angle will always be in front of CD, the posterior side of the radius being always this much nearer the hand than the anterior. When it approaches 10 degrees in a broken radius there is suspicion of a change of plane antero posterior, and many times it will show obliteration or even reversal of the angle (Figs 3 9 10). If impossible of correction, it will mean a certain prominence always of the wrist and a backward tendency to the hand. It is up to the individual operator whether he will attempt to correct this tendency or whether he will not do so, but at any rate he will thus be able to recognize the condition and be prepared to explain it satisfactorily to his patient. It is surprising how little deformity persists sometimes even when the destruction has been sufficient to reverse the normal angle at the joint. Fig 9 shows this reversal of the angle and Fig 16 shows how little deformity with a perfectly movable hand resulted from this apparent great change of plane. This is the real explanation of these cases of abnormal prominence which persist rather than the loosening up of the flexor tendon sheaths from their attachment to the bone, to which it has often been ascribed.

CLASSIFICATIONS First—*Simple transverse fracture* of the bone with little or no evidence of compression. These are more often the automobile fractures. The mechanics of the fracture are the same, but the force is

not great enough, except in rare instances, to badly damage the structure

Second—*Fracture of the lower end of the radius with evidence of great compressive force* There is here actual loss of substance on the posterior surface of the bone, so-called impaction Flexion, cracks, or fissures may or may not exist on the opposite side The planes of the articulation are always changed, much or little

Third—*Fractures of the lower end of the radius with displacement of the distal fragment backward and sometimes in abduction* Often there is impingement of this fragment on the posterior sharp surface of the proximal fragment, the so-called rotation of the fragment The same injury oftentimes breaks the styloid of the ulna or even the ulnar shaft, but the ulnar break is always secondary to the main break and not a compression break

The break of the ulnar styloid is simply a sheering fracture The break in the radius lets the ulna down so that the styloid meets resistance and is sheered off

The ulnar fracture higher up in a simple transverse tension breaks as the resultant of two forces, secondary to the main break The man falls forward, his arm bent at the elbow The muscles of his arm are resisting the fall and trying to straighten the elbow The force below on the end of the ulna is acting also to bend it Result, a transverse tension break of the ulna

If continued the force may push the ulnar shaft through the skin, but these do not form a special type There are only three types and all fractures of the lower end of the bone fall readily into these three different forms Whether the ulnar styloid is broken or not is unimportant If the ulna above has been broken we have a different problem, but a different problem only as regards treatment Let us go further with this inquiry, since the fracture of the bone is not the only thing which happens, and is, in fact, barring disturbance of planes, one of the least important The wrist is a compact structure Running through this restricted area, both front and back, are many tendons with their tendon sheaths and slips of connective tissue binding them closely to the bone, blood-vessels, nerves and ligaments The position of the hand as the patient falls relaxes all the extensor tendons at the back of the wrist and correspondingly tenses all the flexors The flexor tendons, especially at the bending moment, are under a tremendous strain, and as the bone breaks or even before, the connective tissue slips which tie these tendon sheaths to the bones are damaged, torn loose These flexor sheaths and flexor tendons, following strain, react to injury, and we have effusion into the tendon sheaths and more or less bleeding

If now the distal fragment is dislocated we may have further injury to the flexors, particularly the flexor carpi radialis, because of its insertion nearer the break and consequently greater tension, by the sharp anterior surface of the proximal fragment The extensor tendons are

not in tension, the wrist is hyperextended, the weight of the load plus the tension of all the flexor tendons forces the fragment backwards. The fragment tilts and the sharp posterior edge of the proximal fragment locks it, impingement. The extensors and abductors of the thumb and the radial nerve may be injured by the sharp posterior edge of the distal fragment as it goes backward into dislocation, but usually the injury is not severe. The extensor carpi radialis longior and the extensor carpi radialis brevior, because of their insertion comparatively near the fracture, are now tensed across the distal fragment. The extensor longus pollicis, because of the same reason and its short length and oblique position, with reference to the distal fragment, is also under tension. The terminal phalanx of the thumb is extended and it is difficult to flex this phalanx. The thumb can be approximated to the palm, but the terminal phalanx of the thumb remains extended and this extension is a good point to remember as gauging the accomplishment of a good reduction, because the moment the lower fragment is reduced the terminal phalanx of the thumb can be flexed. The extensor longus pollicis is restored to its normal condition and the tension is removed.

In the abduction Colles, the deformity is even more pronounced than in the posterior displacement, because here you usually have a combination of posterior and abduction deformity, but once reduced, even the obliquity of the fracture, if such exist, is not a tremendously serious drawback, because if one considers the normal anatomy of the wrist-joint he will find that only two muscles are attached to the fragment, the supinator longus or brachio radialis, and the pronator quadratus, one supinator and one pronator, and once reduced the fragments are splinted anatomically behind by the extensor communis digitorum, externally and posteriorly by the extensor carpi radialis longior and brevior and the extensor longus pollicis tendons to prevent backward displacement, and how better could one prevent abduction deformity from recurring than the presence of the extensor ossis metacarpi pollicis and the extensor brevis pollicis, which are practically splints over the external aspect of the joint.

The only fly in the ointment, as it were, is the pull of the supinator longus attached to the lower external surface of the humerus and inserted into the very tip of the styloid process, which does tend both to produce and to perpetuate the flattening of the lateral plane of the joint by tending to abduct this distal fragment.

Adduction is the only remedy which we have and restriction for a few days of the action of the supinator longus by splints and bandaging. This is why we leave abduction movement to the last and is the most important reason for splinting. In front are the flexor carpi radialis, the flexor longus pollicis, and the long flexors, and, as a splint is of use only to prevent recurrence of deformity, principally by limiting muscular action, what better splinting could be imagined than by this large number of tendons playing across the broken surface?

Reduction is the first consideration and, of course, comes before there is any necessity for the determination of planes, but it has seemed better to us, for the purposes of this article, to discuss the question of planes before taking up the reduction, because we can do so much to correct this disturbance if we have a clear conception of what has happened and of the mechanical problem before us. There has been no improvement in the old method of reduction of a Colles fracture, hyperextension of the hand, local pressure downward on the distal fragment, strong flexion, and stronger adduction with local pressure. Circumduction is never necessary. The ulnar styloid is not entangled in the torn ligament. The soft tissue may fall somewhat between bony fragments wherever there is a break, but circumduction is an unnecessary manoeuvre. With the thumb extended strongly the extensor longus pollicis is relaxed, with the hand hyperextended strongly, the extensor carpi radialis longior, the extensor carpi radialis brevior, and the long extensors are also relaxed. The flexors are under no particular degree of tension except possibly the flexor carpi ulnaris, and this only when there is a forward dislocation of the ulna, and, therefore, need not be considered. In hyperextension the fragment moves freely because released from its bow-string retainers, and with the thumb can be pushed forward easily. As the hand is swung downward into flexion and strong adduction at the same time, the bones slip into place and are held firmly by the tendons. Adduct strongly with local pressure to correct the lateral plane as much as possible. Without this manoeuvre of hyperextension one cannot move these broken radii. Why? Because the distal fragment is tilted backward and five bow-strings are thrown across it under tension, the common extensor, the extensor indicis, the extensor longus pollicis, the extensor carpi radialis longior, and the extensor carpi radialis brevior, and combined they are strong enough to resist a tremendous amount of pull. There is usually an effusion into the tendon sheaths which shows pronouncedly over the common extensor and the extensor longus pollicis, where displacement has taken place, and this may and does persist for a long time. It also accounts for the pain on the back of the hand from the pressure of a hard posterior splint. This exudate also exists in the flexor sheaths and to a greater extent, since they are usually more traumatized by stress, and this accounts for some of the temporary prominence of the front of the wrist at this time. We will assume that reduction has been effected, the important parts of which are as we have said, hyperextension unlocking the fragment from its bow-string retainers and from its impingement, sharp flexion and adduction of the hand with local pressure added to reduce the posterior and abduction deformity. Flexion and extension are now possible and free. Try them, actively, but do not abduct. The main point which one wishes to know about every Colles once the reduction is effected is the damage to tendons and nerves. One can rest one's mind easy about the bones slipping out of place. Lay the arm

extensor side downward upon a flat surface Can he flex the terminal phalanx of his thumb and extend his thumb at the same time? The extensor longus pollicis tendon is free of tension and the posterior displacement of the distal fragment must be, therefore, reduced Can he approximate the thumb and little finger? The deep branch of the ulnar has escaped injury The superficial branch of the ulnar is entirely sensory and is given off below the wrist, but if it were injured, there would be anæsthesia of the little finger and inner side of the ring finger and inner side of the hand In injury of the ulnar nerve at the wrist there is no weakness of the flexors, but the interossei and hypothenar muscles are affected and also the adductor obliquus and transversus pollicis, and the short head of the flexor brevis pollicis The fingers cannot be spread widely apart This is a movement by the interossei, and all the interossei, palmar and dorsal, are innervated by the deep branch of the ulnar nerve If the median nerve is injured at this level, there is a paralysis of the short flexor and abductor muscles of the thumb and the two outer lumbricales The index and middle finger can be flexed by the action of the long flexors, but the first phalanx cannot be flexed while the middle and terminal phalanges are kept extended This movement is done by the lumbricales, and the two outer lumbricales are innervated by the median It will also be difficult for him to approximate his thumb and index finger because of paralysis of the short flexors of the thumb, but the lumbrical action is decidedly a better guide because of the ulnar innervation of some of the short thumb muscles There will be anæsthesia of the palmar surface of the thumb, two outer and half the ring fingers If the radial is injured do not look for the classical anæsthesia following the anatomical distribution of this nerve, extensor surface of the thumb, index, and middle fingers You will rarely, if ever, find it It is more likely that a small area of anæsthesia will be found on the back of the hand between the thumb and index finger The nerve is sensory and no muscle paralysis follows Have any of the long flexors or extensors of the wrist been injured or ruptured? He flexes his hand at the wrist Let him do so gently, the fragments will not come out of place His flexors are intact Let him extend his hand, but not beyond the horizontal plane The extensors are intact Let him adduct his hand, the flexor carpi ulnaris and the extensor carpi ulnaris are intact The thumb extensor is the one most apt to be injured Flex and extend the thumb It is intact Do not abduct at all, do not pronate or supinate These are the only motions which he should not do In nine cases out of ten it would do no harm if he did, but there is no need of taking chances on the tenth case The patient with a reduced Colles should be able immediately to move the wrist and fingers sufficiently to demonstrate these facts We now apply our splints, and once the reduction is effected almost any old splint will answer the purpose In other words, it is not the splint which is important, they are put on simply to put the muscles at rest Theo-

retically a bad Colles should be put up with flexion at the wrist, strong adduction, and the hand carried in the position of supination, to relax the supinator longus muscle, but practically it is not necessary, and not comfortable. Personally, we use an anterior and posterior splint with ulnar and thenar cut-outs angled at the wrist in adduction thirty degrees, in bad cases. In mild cases the straight splint is good enough. The Walker is a good anterior splint, but not so convenient for the after treatment which we use.

If all patients were intelligent and had a good understanding of the mechanics of Colles' fracture, nothing but a wrist strap of leather would be required in any of these cases other than the abduction Colles or the one with comminution of the bone. But a splint is of value for impressing upon the mind of the patient the fact that he has a broken wrist. He can never forget it, even for a moment, and this is its greatest advantage. We must use a splint with a large ulnar cut out. Most of these ulnar cut-outs are too small. A strip of board along the posterior surface of the radius would be just as good without including the ulna at all. This permits the ulna to be pressed backward into its proper place, and the tendency is rather to push it forward. The position of the ulna is decidedly posterior and when this is not taken into account in these cases with ulna dislocation, the ulnar prominence is afterwards lost. This posterior splint should never go below midway of the metacarpal bones, leaving all the extensors of the fingers free, an angled board for the anterior splint with cut-out for the thenar eminence. The thumb must be free. In cases where no displacement has taken place, a simple two-inch by two-inch board across the wrist for the anterior splint is sufficient, but here, again, the long anterior splint is of advantage for the first few days simply to impress the patient. If the fracture is satisfactory as shown by the X-ray, the patient is dismissed for twenty-four hours. If the splints are not too tight, he will seldom suffer a great deal of pain, but in certain neurotic types one should expect a certain amount of discomfort. The majority are perfectly comfortable.

The thumb and fingers are used actively from the first. The patient is instructed to approximate the thumb to all the fingers a dozen or more times a day and to flex and extend his fingers and thumb whenever he thinks of it. The thumb is the one digit most likely to show a slight restriction in motion and some numbness which passes within the next few days. Twelve to twenty-four hours afterwards the anterior splint is removed and passive motion begun at the wrist very gently. I usually leave the posterior splint on during this passive motion for the first few days and with my left hand across the radius prevent abduction movements of the hand by pressure over the insertion of the brachioradialis muscle. The thumb is flexed and extended, the hand is flexed on the wrist, but not extended on the first day beyond the posterior splint. There is no pain in these manipulations. If the fracture is a simple type

one case, I begin active motion at the wrist on this first day, permitting him to flex and extend his wrist, to move his thumb and fingers and to approximate the same, to try the adduction movement where there is no broken ulnar styloid, but not to abduct (Fig 12) In this class one type I know that I might safely substitute a plain leather wrist strap on this day without fear if I cared to do so, and in some intelligent patients I have so done There is, however, nothing to be accomplished by this, because by the time that one is willing to turn these cases out free from restriction, their wrists are flexible, and if we do not gain time it is certainly not advisable The point of the entire treatment is motion quickly In the more serious cases motion is given the joint every day for ten to fifteen minutes passively, and on the third or fourth day active motions are substituted for passive In fact, in the majority of these cases, active motions are begun on the second day Abduction motions are usually left until after seven or eight days If the case is a simple automobile injury without displacement, at the second or third dressing the posterior splint is cut to a strip about one and one-half inches wide along the posterior border of the radius with a two-by-two piece of board well padded anteriorly, the padding being especially thick over the ulna in order to press it backwards (Fig 11) The posterior splint in this second dressing extends slightly below the wrist-joint in order to limit extension and only a short distance above the fracture This allows for a certain degree of motion at the wrist which is desirable The arm is still carried in a sling, a narrow one, not one which encircles the whole forearm By the sixth day all anterior splints are off, save plaster strapping, and by the ninth day all splints are off except a wrist strip of leather with an ulnar cut-out, which is worn from this time on (Fig 12) How long a patient wears this is a matter for himself to decide Some of them like the feeling of it and wear it for some time Be sure not to buckle it too tightly Be sure the ulnar cut-out is large enough If there is comminution of fragments, if there is an abduction Colles with tendency to displacement of the distal fragment on account of an oblique fracture, do not go so fast, but even in these cases by the tenth or twelfth day all danger of dislocation will have passed under ordinary care In these cases it is well to wear splints longer and to institute active motion later, but one should not wait too long even here A stiff wrist is not a comfort to its possessor, and one that begins to stiffen is hard to loosen up It is easier to prevent this than to recover the motion after it has been lost This applies to all joint fractures Do not permit the joints to stiffen in the first place This can be accomplished by early active and passive motion in every case In a region which is so crowded with tendons and important structures as the wrist, an injury to this region is always a serious matter, and as these cases are handled to-day a simple automobile crack seems to be quite as serious to the patient as a more serious break with displacement The joint is locked up, is looked at

occasionally, and after three or four or even five weeks is worked, baked, massaged, etc. The patient is out of commission three, four, or five months, and many of them I have seen out of commission for over a year. None of them recover their motion for a long time, and some of them do not recover full motion at all. Deformity does not seem to influence the result so far as motion is concerned to the degree one would expect. A wrist without deformity often shows restriction of motion, while a badly replaced one shows practically a normal wrist motion. This is in line with my contention, first, that there is a traumatic arthritis of the joint with effusion into the joint. Lock this up and it will be stiff no matter what you do. Second, the tendons, flexors, and sometimes the extensors are traumatized, their attachment to the bone is torn, their bursa are filled with inflammatory reaction products. The subcutaneous connective tissue structures are traumatized and infiltrated with leucocytes. The anterior radiocarpal ligaments may be torn, the posterior never, but I have purposely avoided mentioning them specifically. Their importance has been overestimated. They belong only in the concomitant injuries of soft tissue. They play no major part either in the mechanics of the production of these fractures, their reduction, or their treatment. I know that I am controverting many pet theories, but I believe that they simply belong in the class of the generally injured soft structures. Of vastly more importance is the ruptured inferior radio-ulnar ligament, widening the joint by ulnar separation, and this feature is adequately cared for by forcing the ulnar sufficiently backward. Leave this mass alone, rigid, to organize and bind down tendons and wrist structures and then expect motion? Is it rational? We might just as well open the wrist, turn in a quantity of glue or plaster of Paris, if it could be done, and then expect the joint to functionate. By early gentle motion we free these tendons, prevent adhesions, limit the degree of scar formation, and get a functioning joint early. After all, does it work out? I have space here for only a few illustrations, but I have many more cases which I could use. Four will be sufficient, since they are all fractures which show the compression feature which is the important feature of the bony injury, is always present in bad cases, and cannot be overcome entirely by reduction. It could be entirely taken care of, but at the expense of wrist motion.

CASE I (Fig 12) —Man, aged thirty-five years. Compression fracture of the lower end of the radius. Type II. Broken ulnar styloid. Planes restored. Active motion second day. Splints off tenth day. Painted a picture on the seventeenth day. Drove a horse race on the nineteenth day of the injury, but not with our permission. This represents the main danger of this treatment, carelessness of the patient. No harm resulted.

CASE II (Figs 10 and 13) —Mrs. D., aged sixty-eight years. Compression injury. Lower end of the radius. Concomitant injury,

broken fragment of the external condyle of humerus Discharged the nineteenth day No subsequent trouble

CASE III—T P, man Fig 14 shows X-ray after reduction Planes good Fig 15 shows motion twelfth day Sailed for Europe on the nineteenth day Some little tenderness over the ulna persisted for some weeks Motions good Used hands for all purposes after the fourteenth day

CASE IV (Fig 5)—S T, man Active working second day Anterior splint off fourth day Fig 6 shows motion on tenth day Discharged twentieth day X-ray shows disturbance of the antero-posterior plane not so pronounced as Fig 3 Result satisfactory

Will there be cases of traumatic arthritis, those cases which show good motion at first and later lose it, the thing which every surgeon fears? Of course, there will be as there has been in the past, but not on account of the treatment, and in no greater or as great numbers as before We had some of them under the old treatment, we shall have some under the new

Résumé—The treatment of Colles' fractures, or, as I term them, compression fractures of the radius, as dealt with at present and as handled in most of the larger hospitals of the country, save for a few individual members of the medical profession, belongs to the mediæval era when men discussed the important question of how many angels could dance on the point of a needle In fact, the whole subject of joint fractures and joint injuries must be taken up and worked out on the basis of results obtained rather than upon the basis of what some one man who is supposed to know thinks We have too long accepted as final some one man's judgment of what is and is not the correct thing to do in certain pathological conditions, and have found out later on that he was fallible like the rest of us

Colles' fracture and, in fact, all joint fractures, are to-day upon a different plane than ever before War and the compensation acts of various states have made it a commercial proposition, and it has become a serious necessity to turn back these cases of joint injury into their respective channels of productivity as soon as possible In other words, it is a factor to be considered in the ordinary overhead of the commercial world It costs money, and that cost is to-day apportioned to the industry to which injured men belong and, therefore, competition is the driving force to compel efficiency Colles' fracture certainly contributes to the overhead expenses of corporations, insurance companies, and individuals in this country probably as much or more than any one fracture Stimson said years ago, a statement which he could make with equal truth to-day, that there were more Colles' fractures with bad results than any other type of fracture, and he added to his statement that he had seen more bad results from treatment in the great metropolitan hospitals than anywhere else The burden of expense caused by this one fracture, the

loss of time, the loss of wages, the loss of productivity is enormous. The treatment of these fractures one hundred years ago would not make a bad comparison with the treatment which is generally in vogue to-day. It makes a vast difference to the economic scheme of existence whether the thousands of Colles' fractures which are happening in this country every day are invalided from three to six months, as they are, or whether they are returned to work within a reasonable length of time, and nine out of ten Colles can be returned to light work within twenty days with advantage to the country's economic condition, and equal advantage to the man who has the Colles. When we begin to compute the actual saving the figures are simply astonishing, and if this country of ours is to go ahead, is to exist even, after the present fandango of high prices for employers and employees and trades people has passed, it will be more than ever necessary to eliminate the waste. We are facing a competition which is coming that will make us think that in our pre-war days we had none. The treatment of Colles' fracture as responsible for economic waste would be a good subject for investigation.

SUMMARY

1 Fractures of the lower end of the radius (so-called Colles) are always compression fractures, the compressive side breaking first, literally collapsing.

The first point of fracture is the point of greatest compression upon the cortical surface of the bone because the stress increases both in compression and tension the further away from the neutral axis.

2 It breaks in compression because the compression is much greater than the tension. Green bone reacts to strain like wet timber. It breaks at the lower end of the radius because there are several forces, and the resultant is on the lower end of the radius posteriorly. This is due to direct compression from above, the hammer blow from below, the resistance both to compression and to blow being not in the centre of gravity, but eccentric to it and, therefore, increasing the strain. It is also due in part to the velocity of stress and the molecular inertia of material.

3 These compressive fractures of the lower end of the radius show the evidence of compression. There is actual loss of substance, but no impaction. Breaking up the impaction (so-called) cannot restore the planes of the articulation, nor does it do so.

It might be possible by traction over a long period of time to separate this crushed surface and permit its being filled in by new bone, thus restoring the planes of the articulation, but to do this would be to sacrifice some of our chances of securing a freely movable wrist-joint.

4 Early reduction followed by early passive and active motion will return all or nearly all compressive fractures of the radius to useful light occupation within twenty days. Any retentive apparatus other than a leather wrist strap after ten to twelve days is contraindicated except in a very rare instance.

PSEUDOMYXOMA PERITONEI †

WITH REPORT OF SIX CASES

BY MONTGOMERY H. BIGGS, M D

OF RUTHERFORDTON, N C

FIRST described by Werth, in 1884, pseudomyxoma peritonei has received but scant mention in the English language and few cases have been reported by American writers. A general review of the literature, however, shows that its recognition is becoming more frequent.

I operated on my first case in 1907, and was able to keep this patient under observation until her death in 1916. The nature of the condition was recognized and a confirmatory pathological report secured. Since that time I have operated on five other cases in which microscopic examinations have been made, and one case, not included in this series, in which the specimen was lost, but clinically there was no doubt as to the diagnosis. All specimens have been examined in the Laboratory of Gynecology of the University of Pennsylvania, pathological reports having been made in the first case by Dr B M Anspach, and in the other five cases by Dr C C Norris. Only a few weeks ago my colleague, Dr Henry Norris, operated for this condition and the patient has made a most satisfactory recovery.

Pseudomyxoma peritonei may be described as an inflammation or irritation of the peritoneum, caused by the discharge of the epithelial lining and the contents of a pseudomyxomatous cyst of the ovary or appendix, and resulting in the production of pseudomucin and secondary tumor formation.

The pathology of this condition, even to-day, is ill-defined, but in some of its phases it is particularly interesting. Quoting from the original paper by Werth: "The gelatinous contents of the cyst contain chemical substances which are not soluble in water and cannot, therefore, be absorbed by the peritoneum. Even if the peritoneum could absorb these substances they could not be carried in the lymph channels because these spaces would become obstructed. Therefore, these remain and travel into all parts of the peritoneal cavity on account of the peristaltic activity of the intestine. They act as foreign bodies on the serosa and stimulate the formation of new vessels and connective tissue."

In contradistinction to this original view of Werth, Olshausen, Pfannenstiel and others believe that the process is an implantation metastasis from a primary ovarian tumor, while Fraenkel states that the metastases are not complications but are part of the original process.

In a contribution to the subject by Goldschmid, he states that gynæcol-

† Read before the Southern Surgical Association, December 17, 1919

ogists have held that it was a true metastasis from displacement of epithelial cells, with new growth of mucous masses, while anatomists have held that it was merely the organization of mucous masses from the tumor

To my mind the most tenable theory as to etiology is that of cellular implantation the epithelial cells lining the cyst, together with the pseudomucinous content of the cyst, being discharged through a rupture of the cyst wall into the peritoneal cavity, the cells there functioning as they did in their original situation

We must attempt to explain the rupture of pseudomucinous cysts without the production of pseudomyxoma That this frequently happens cannot be doubted Rupture of the ovarian cyst usually occurs in the larger loculi, which are distended, the walls are thinned, and the point of rupture is lined by partially degenerated or comparatively inactive epithelial cells Few cells are apt to be discharged with the pseudomucin, and these cells are not good plants Further, as a rule, the loculi in which the fluid is not under much tension are lined by columnar epithelial cells that are very active These cells usually appear to be rather firmly attached to their basement membrane and are not easily displaced, so that even if the smaller loculi are ruptured, few if any epithelial cells may escape These facts probably account for the comparative rarity with which pseudomyxoma develops, even when there has been rupture and sufficient time has elapsed prior to operation or death to allow for growth Active cells are not the rule in the appendix but are almost constant in pseudomyxomatous cysts of both the appendix and ovary, and they are often loaded with pseudomucin When they are discharged in larger number than can be resisted or destroyed by the peritoneum, they become attached, grow, function, and cause pseudomyxoma A close study of cases will show that the new growth follows the primary form in histologic characteristics and produces the same type of material

At first this condition was considered, in every instance, to be the sequel to a previously existing ovarian cyst, but it remained for Fraenkel, in 1901, to observe that the appendix may be the seat of the primary pathology In numerous reported cases in which both an ovary and the appendix were the seats of this condition, it has been demonstrated that they were independent in origin In my series the appendix was affected in three cases, of which two showed transplants, and in one it was the seat of a mucocele Secondary involvement of the appendix is not remarkable, as any organ covered by peritoneum can be attacked

I would say that pseudomyxoma has no distinctive symptomatology, except when the lesions are advanced and widespread The symptoms manifested are usually those due to mechanical interference with function and may be caused by blocking or closure of the lymph spaces, cutting off of the blood supply, thickening of the peritoneal covering of organs, resulting in tumor formation on their surfaces and encroaching on func-

tionating tissue. Constriction of the intestine is not uncommon. Early cases will be discovered at operation, late cases presenting effusion with irregular, firm tumor formations distributed throughout the abdominal cavity can be diagnosed pre-operatively.

The early history of these cases can yield but little information other than that pointing to the existence of an ovarian cyst or a chronically diseased appendix. Ordinarily the statements of the patient when first seen are not helpful, as is illustrated by the following list of "reasons for seeking the surgeon" in my series: Case I, distention, weight, pain, shortness of breath; Case II, uterine bleeding from multiple myomata; Case III, pain, abdominal distention, vomiting, fever, loss of weight; Case IV, pelvic pain, backache, weakness, loss of flesh, constipation; Case V, pain left side and pelvis, bearing-down feeling, indigestion, loss of weight, menorrhagia; Case VI, fulness of stomach after eating, distended abdomen, frequent micturition, slight pelvic pain. Only in the terminal stages will the patient show weakness, loss of weight and an appearance bordering on cachexia.

The age of the patient is an aid in establishing the diagnosis. While there are a few instances of its occurrence in earlier years, it is generally seen in advanced life, after the menopause and at a time when many lesions of the female genitalia can be excluded. My youngest patient was forty-one years, and the oldest seventy-eight years, the average being over sixty.

Statistics do not seem to help us in determining whether the course is rapid or slow, but a logical deduction from reported cases and those personally observed, would be that it is not rapid until well advanced, and when a part of the original growth has been left at operation. Even at this stage it may be slow, as in case one of this series, which was by far the most severe when first seen, and death did not result for nine years. The other five cases are living at periods of twenty-eight months, twenty-six months, sixteen months, twenty-two months, and twenty-five months after operation. In two of the cases there was recurrence, one after twenty-six months, the other after seven years. Strangely the time of recurrence does not seem to bear any relation to the severity of the lesions.

I feel much more optimistic regarding the outcome of these cases than some previous writers. It will be found stated that recurrence is early, that the incisions are liable to become infected, that pseudomucin is a good culture medium, that the operation is unusually hazardous, and that it should be regarded as a form of cancer. My operative results do not justify these statements. Of the cases here reported the earliest recurrence was in twenty-six months, in no case was the wound infected, although in one case twelve operations were done, intra-abdominal suppuration did not occur, there was no operative mortality, the only death being nine years after the patient was first seen, at which time

there were large tumor masses throughout the abdomen. Weighing against malignancy also is the fact that it is not a rapidly destructive process. Multiple metastases may be widely distributed and the wall of the original cyst, which perhaps has been existent for years, remains intact. The process is not destructive to tissue in the way that is seen in cancer. In only one of my cases was the microscopic appearance even suggestive of malignancy. She was seventy-two years old, is now living, has had no recurrence after more than two years, and reports a gain of between fifty and sixty pounds in weight.

The findings at operation vary in wide degree. In all the reported cases to which I have had access there has been a cyst, either of the appendix or ovary, or both. There is present more or less pseudomucin, which in color is a shade of yellow, in consistency it may be thin, viscid, jelly-like or thick, tenacious and stringy, and it may contain sago-like bodies. If in small quantity it will be free in the pelvis. In larger quantity it may show all the characteristics mentioned, it will be distributed like any effusion, is apt to cling to the peritoneum, and the thicker portion is removed with difficulty. The largest quantity that I have removed at one operation was thirty-five pounds, and the largest total removed from one patient was three hundred and fifty pounds at twelve operations.

In late cases there will be actual tumors on the abdominal viscera and great thickening of tissues. I have seen almost the entire colon enormously enlarged, covered by cysts and nodular formations, and the mesocolon from one-half to one inch thick. These new formations are hard to describe, but when once seen will not be confused with other conditions. They may be made up of small cysts of varying sizes and imbedded in indurated but edematous-appearing structure, and are rather whitish and opaque.

I have noted in my cases that the peritoneum surrounding these secondary growths, as well as that under the jelly-like material in earlier cases, did not simply resemble an inflammation, but bore a stippled or rather fine pebbly appearance without actual macroscopic cystic formation. This I believe to be the early stage of pseudomucinous development in the peritoneum, and when present together with gelatinous material I think we may say we are dealing with pseudomyxoma peritonei. That the lesion need not present a striking appearance to be potent is well illustrated by a case reported by Eden, which he operated twice. At the first operation he mentions the exudate and says, "This jelly-like material was adherent to the peritoneum, which in turn was injected." At a second operation two years later the opposite ovary and the appendix were the sites of advanced lesions. Unless the pseudomucin and cellular elements have been deposited very recently, or are impotent, I think that careful observation will show not only injection

but the rather diagnostic pebbly appearance of the peritoneum, which is an early stage of cystic development

It has been pointed out by others, and my observation verifies the view, that all the original tumor should be removed if possible. This is sometimes difficult and even unattainable when adhesions are very firm and highly vascularized. In the only case in which I was compelled to leave a portion of the original cyst wall deep in the pelvis and adherent to the rectum, there was recurrence in slightly over two years. It is unfortunate that the secondary formations cannot always be removed, both to accomplish a cure and for sectioning, the hollow viscera seeming to be most frequently attacked. From one patient I removed a section of the mesentery for examination, without any ill results.

If the original lesion is entirely extirpated, all pseudomucin removed, and affected areas of the peritoneum carefully wiped off with wet gauze, I believe that in early cases cures will often result and certainly the patients may be free from recurrence for many years.

CASE I—Mrs B G, aged sixty-six years, white. Has had paralysis agitans for several years. Nearly three years before coming under observation noticed pain in right lower abdomen and one year ago some swelling in this region. A little later she was conscious of a small tender mass on the left side. Abdominal enlargement had been gradual and there had been some general abdominal pain. There is no history of change in contour of abdomen or disappearance of mass. When first seen the abdomen contained considerable fluid, there was a large irregular mass in the hypochondriac region, another mass was palpable in the suprapubic region. These were firm, movable under the abdominal wall, and in certain areas had rather sharp edges like the liver or spleen.

At operation, July 16, 1907, there was a large thin walled cyst occupying the greater part of the abdominal cavity and attached to the left broad ligament. It contained syrupy, straw-colored fluid. The tumor base, the colon and the entire mesentery were the seats of new growths, the mesentery in places being from one-half to one inch thick. A section of the mesentery was removed for microscopic examination.

She made a perfect recovery and remained free from symptoms nearly seven years, when about thirty-five pounds of gelatinous fluid was removed. From that time on recurrence was more rapid and in the next two years ten operations were done and a total of pseudomucin at the twelve operations was three hundred and fifty pounds. At the time of her death, August twenty-eighth, 1916, the abdomen was well filled with irregular new growth.

Summarized Pathological Report—The section shows a reticulum of fibrous tissues well supplied with blood-vessels and here and there infiltrated with small round cells. Between the fibrous tissue branches are areas made up of fatty areolar tissue, the combination having the appearance of normal omentum. In close connection, between branching arms of fibrous tissue, are areas which

take on a faint blue color and consist of apparently homogeneous semi-fluid material, evidently pseudomucin. The pseudomucinous collections are completely surrounded by the fibrous reticulum, and, for the most part, the enclosed spaces are bereft of any epithelial lining, the pseudomucin being in direct contact with the fibrous tissue. One or two areas are found, however, in which a vestige of epithelium is found lining the pseudomucinous space. This epithelium is of a high columnar type. None of the cells wherever found show any proliferative changes which suggest malignancy. The condition, therefore, is taken to be an implantation metastasis and subsequent growth of particles of a pseudomucinous cyst of the ovary.

Diagnosis—Pseudomyxoma of the omentum and peritoneum

CASE II—Miss H. D., aged forty-one years, white. One month previous to admission noticed a small mass in the lower abdomen, for nearly a year has had menorrhagia. She now shows the effects of hemorrhage and hard work. Vaginal examination reveals some small fibromata of the uterus and a left-sided cyst.

At operation, in addition to a fibroid uterus and an ovarian cyst, there was about two ounces of gelatinous material in the pelvis, and the left broad ligament and part of the peritoneum covering the bladder were red and had a pebbly appearance. The appendix was adherent, enlarged and was removed, and a sub-total hysterectomy done.

Summarized Pathological Report—Surface of ovarian cyst is for most part smooth, but there are some adhesions. The lining consists of a single layer of high columnar cells which possess basal nuclei, these are deeply staining. The plasma takes a hematoxylin stain palely. Stroma is made up of loosely arranged connective tissue, which in many areas is edematous. In the smaller loculi the surface epithelium is high, whereas in the larger ones it is comparatively flat. The loculi contain pseudomucin. Nothing suggestive of malignancy is present. The surface of the appendix shows a number of irregular tags and adhesions. In one or two areas the surface is covered by a single layer of flat epithelial-like cells, these are rather small, the nuclei relatively large and deeply staining. The cells are for the most part broader than long, here and there a few which somewhat resemble columnar epithelium are observed. For the most part cells are arranged in a single layer, at two points small elevations are seen which consist of a stroma and are covered by a single layer of the above described cells. Muscularis, mucosa and submucosa show usual changes observed in a mild chronic diffuse appendicitis.

Diagnosis—Cystadenoma ovarii pseudomucinosum glandulare (left), Deposition of pseudomucin upon surface of appendix.

This patient reports herself well three years and four months after operation.

CASE III—Mrs. M. W., white, aged seventy-eight years, married but nulliparous, never ill in her life except two attacks of influenza, menopause at fifty, without symptoms. Six weeks ago noticed that abdomen was gradually getting larger, and two weeks ago went to bed on account of pain and discomfort, since this time abdominal distension has been rapid. For forty years her abdomen has been "big, but she thought it was her build." There was no change in size of abdomen until six weeks ago. On admission abdomen is

enormously distended, fluctuation slight, peristalsis good, no edema anywhere, temperature 101, pulse 120, has vomited considerably and has been denied food for several days

Operations—Small incision under local anæsthesia to evacuate fluid, but it would not run, even with the patient inverted. Palpation through wound discovers small cyst on left covered by nodules. A few days later operated under general anæsthesia, thirty pounds of very thick material, which was for the most part clear, removed, the cyst was deep in the pelvis, covered with cystic nodules, densely adherent to surrounding structures, and the base so firmly attached and so hemorrhagic that a small portion of it could not be removed. Pelvic peritoneum and all pelvic organs show inflammation. Appendix appeared normal.

Summarized Pathological Report—Ovarian cyst shows adhesions, is made up of fibrous tissue with hyaline degeneration present, considerable infiltration of plasma cells, small round cells and few polymorphonuclear leucocytes. Blood-vessels for most part dilated. Inner surface of cyst covered by high columnar type of epithelium, with small oval or round basal nuclei that take hematoxylin stain palely. In no area is there reduplication of the epithelium. Epithelium is very active, many of the cells are swollen, some appear almost bursting with pseudomucin. Much free pseudomucin is also present. Nothing at all suggestive of malignant change is observed.

Diagnosis—Cystadenoma ovarii pseudomucinosum glandulare. Clinically, pseudomyxoma peritonei.

This patient remained free from effusion for two years, and since that time has been tapped twice, her general condition is good. She makes the following written report: "Considering my age, am as strong as I could expect."

CASE IV—E. G., colored, aged seventy-two years. Patient comes to hospital because of pelvic pain, backache, weakness, loss of flesh, obstipation. She is thin, anæmic, muscles flaccid. Examination shows pelvis to be filled by a firm immobile mass, indicating dense adhesions of organs so that they cannot be defined. Abdomen not distended, no abdominal effusion detected. At operation, November, 1917, pelvis is occupied by a mass in which was fused intestine and overlying this mass about half a pint of gelatinous material. When this is removed and dense adhesions freed there is a small cyst on left side and numerous pockets containing gelatinous material. Cyst is fused to uterus and surrounding structures, is dissected out with difficulty, and uterus is so denuded of peritoneum that it is removed with the cyst and careful peritonization done.

Summarized Pathological Report—Capsule composed of fibrous connective tissue which in some fields presents areas of degeneration and infiltration with inflammatory processes. The inner surface of tumor is covered with a single layer of cells which possess basal nuclei and take hematoxylin stain rather deeply, the cytoplasm takes the eosin stain. The outer cells of the surface are swollen, they contain mucus and in many areas present a bulging appearance. Similar types of cells line all the loculi, in the larger ones the cells are flattened, in the small ones they present the high mucous type of cells previously described.

In some fields numerous small loculi are observed which show little or no intra-glandular stroma and which are highly suspicious of malignancy. The epithelium is more or less regular, and in none is marked kariokinesis present.

Diagnosis—Ovarian cyst reducing pseudomyxoma, which is suggestive, but not positive of malignancy.

This patient is living two years and one month after operation and reports a gain of fifty or sixty pounds in weight and perfect health.

CASE V—E V McD, white, aged forty-one years. Patient gives a history of herself discovering a lump in the left lower abdomen last July, which was described as being the size of a goose-egg. Since that time it has grown rapidly in size until it now reaches well above the umbilicus and about three inches to right of median line. It was not accompanied by any pain, discomfort or gynecologic symptoms until about a month ago, since when there has been local left-sided pain, extending somewhat throughout pelvis, a bearing-down feeling, constipation, indigestion, loss of weight and increased menstrual discharge without metrorrhagia. On examination the tumor is to left of uterus, not attached to it and freely mobile, it is evidently a cyst. There is considerable free fluid. At operation, Jan 28, 1918, about four quarts of thin gelatinous fluid is evacuated. A multilocular cyst attached to left broad ligament and free from adhesions is removed. The parts of peritoneum and intestine in contact with the tumor are red and injected. On exposing the appendix, which is in posterior position, it is small but with thickened wall and almost entirely buried in the coats of cæcum, and has to be dissected out. The cæcum is inflamed, thickened and pebbled in appearance, and covered with thick gelatinous material. Peritoneum over front of uterus and over bladder bears the same appearance. On the peritoneum behind the cæcum are two clear thin-walled cysts as large as an ordinary marble. Right ovary, most of right broad ligament, omentum and mesentery are unaffected. Through error the appendix was not sent to the laboratory.

Summarized Pathological Report—A number of sections all show the same general appearance, that of a pseudomucinous cyst. The one peculiarity is that the epithelium appears unusually active, the cells are, if anything, rather higher type than usual, and many are absolutely loaded with pseudomucin. No suspicion of malignancy is observed. There is, however, in some areas a well-defined inflammatory reaction consisting of plasma cells, polymorphonuclear leucocytes, and here and there infiltration of free blood is observed.

Diagnosis—Cystadenoma ovarii pseudomucinosum glandulare (myxoma peritoneal from history).

In her own recent report of her condition she states that she is well and her weight has gone from one hundred pounds to one hundred and sixty pounds at present.

CASE VI—L S, white, aged sixty-two years. About ten years ago noticed slight general enlargement of abdomen, which has increased very slowly, and for last three years has had some pain on moving about and when lifting, frequent micturition, indigestion

and constipation On admission the abdomen is distended, there is a tumor and free fluid

At operation a right ovarian cyst weighing twenty-five pounds is removed There is evacuated from the abdominal cavity six pounds of free, amber, gelatinous fluid The appendix is converted into a multilocular cyst, larger at the base than at the tip, the average diameter being about three-quarters of an inch, and containing clear gelatinous fluid The cæcum was much thickened and injected Balance of intestine and the peritoneum appear normal Cyst is multilocular and the content similar to that free in the abdominal cavity In this case only the appendix was sent for examination

Summarized Pathological Report—Peritoneal surface of appendix shows adhesions In some sections the musculature is thickened, but in others very thin and drawn out All layers are more or less thin in some sections The chief histologic change, however, is found in the epithelium This is unusually luxuriant, swollen, filled with mucus and presents basal nuclei, takes hematoxylin stain palely, nothing suggestive of malignancy Sections from small cyst show this to be lined by a similar type of cell as that just described Here the gland-like arrangement is somewhat irregular and there is a definite formation of the glands In no area, however, is there penetration of the basement membrane, and the only thing at all suggestive of malignancy is the marked increase in the number and size of the glands

Diagnosis—Pseudomyxoma peritonei, Mucocoele of appendix, Ovarian cyst, Retention cyst of appendix

This patient has had no return of symptoms and is reported as thoroughly well

CONCLUSIONS

- 1 This condition is much more frequent than is generally recognized
- 2 It is caused by cellular implantation
- 3 It is histologically benign, but may be clinically malignant
- 4 If it is considered to be a form of cancer, it must be assumed that pseudomucin inhibits its destructive power
- 5 It may originate in the ovary or the intestinal tract, ovarian origin being by far the most frequent
- 6 If it is appendiceal in origin, the appendix has been the seat of chronic inflammation
- 7 Early invasion of the peritoneum is characterized by a pebbly appearance
- 8 In early cases the condition will sometimes be cured, and at any stage it may be inhibited, by operation

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SARCOMA OF THE STOMACH *

WITH REPORT OF THREE CASES

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ALTHOUGH carcinoma is of common incidence, primary sarcoma of the stomach is one of the most unusual forms of neoplasm occurring in that viscus. Its literature is, therefore, largely made up of isolated case reports with but few special articles, and little or nothing is found in most text-books on this subject. Having had the opportunity of operating on three cases, my interest was stimulated to a search of the literature, and to make an attempt to gather therefrom some knowledge of the surgery of this disease. This, with the three case reports, is the basis of this paper.

Frequency of Occurrence—Fenwick, in 1902, stated that sarcoma occurred in 5 to 8 per cent of stomach tumors. Yates, in 1906, 2 per cent, based on records of 800 cases of tumor of the stomach. Ewing, in 1919, gives 1 per cent. Smithies and Ochsner, in 1919, in an analysis of 921 cases of cancer of the stomach, found but 4 cases of sarcoma. Ziesche and Davidsohn, in 1909, from the statistics of various German operative clinics and autopsies estimate 1 per cent. Two of the cases here reported are the only cases of sarcoma of the stomach to be found in the operative records of Bellevue Hospital. During the period from January 1, 1911, to July 1, 1919, eight and one-half years, there were 702 cases diagnosed as carcinoma of the stomach on discharge from Bellevue Hospital. As there were only 97 operations for carcinoma of the stomach and the percentage of autopsies was small, there is the possibility that several of these cases were incorrectly diagnosed. It is of interest to note that of the 97 operative cases of carcinoma, 48, or nearly 50 per cent, died while still in the hospital. The other case of sarcoma of the stomach here reported is the only one from the surgical records of St. Luke's Hospital, N. Y.

Age—The average age of incidence of carcinoma of the stomach, according to the United States Census report of 1911, was 61.2 years. Sarcoma, however, as a rule, occurs in younger patients. Ewing states that lymphosarcoma occurs chiefly in young subjects. The age of the patients with sarcoma reported in the literature ranged from three and one-half to ninety-one years. In a series of 150 cases reported by Ziesche and Davidsohn in 1909, in 118 of which the age was given, the age by decades was first decade, 3, second, 11, third, 18, fourth, 15, fifth, 29, sixth, 24, seventh, 12, and eighth, 6. The average age being 41.6. In a smaller series reported by Burgaud in 1908 the results by decades were practically the same.

Form estimates the period of greatest frequency of occurrences of sarcoma of the stomach as forty to sixty. The average age for lymphosar-

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coma is given as thirty-six years In the cases of my own three patients the ages were thirty-six, thirty-eight, and forty-one years

Sex—The sex of the patients has been almost equally divided in the reported cases

Etiology—Ewing states "The occurrence of atypical productive inflammatory lesions must be regarded as fully in accord with established views regarding the nature of sarcoma, that is, the inflammatory origin of sarcoma, especially lymphosarcoma" He quotes Moser and Kehr that "sarcoma may follow ulcer appears possible, but this relationship has not been satisfactorily proven" This relationship is denied by Lecène and Burgaud, and Levine writes "Lymphosarcoma is only a manifestation of a systemic disease which embraces the whole lymphoid system A discrete tumor of lymphosarcoma is always surrounded by diseased lymphoid tissue, and the operation is followed not by a recurrence, but by the development of the latter tissue into new tumors" This latter statement would appear to be effectually disproven by the number of cases which have survived operation for a considerable time—one case reported as being without recurrence fourteen years after operation In the specimen shown in the illustration it appeared by gross examination as if the large sarcomatous ulcer had originated from the edge of an older cicatrizing ulcer near the pylorus, but this was impossible to prove by microscopical examination

Pathology—Sarcoma of the stomach may be divided into three distinct groups of cases (1) Spindle-cell myosarcoma, (2) lymphosarcoma, (3) miscellaneous round-cell or lymphosarcoma, the nature of which is uncertain They may be diffuse, involving the whole stomach, or form large masses or be polypoid Cantwell removed one weighing 12 pounds Barrington Ward reports a case in which the mass projected into the stomach cavity near the pylorus in such a manner as to obstruct the exit of the stomach A considerable number of cases are reported as exogastric tumors They have, therefore, been classified by Burgaud as exogastric, endogastric, and infiltrating

As the round-cell variety and lymphosarcoma originate in the submucous layer and the spindle cell in the muscular layer, ulceration does not occur as readily as in carcinoma, which originates in the epithelial layer Lymphosarcoma and the round-cell variety are usually infiltrating, while the spindle cell or myosarcomata form discrete tumors which may either be sessile or peduncleated and often grow to a large size At a recent meeting of the New York Pathological Society Pagenstecher showed a specimen of myosarcoma which weighed 11 pounds Cystic degeneration of these larger tumors not infrequently occurs

Concerning the relative frequency with which the various forms of sarcoma occurred, Forni, in an analysis of 200 cases, in 190 of which the variety of the lesion was noted, found round-cell (including lymphosarcoma) in 98, spindle-cell in 39, polymorphous structure in 14, and special forms as

angio or myosarcoma in 39 According to Hesse, perforation occurs in 8 per cent of the cases

Round-cell and lymphosarcomata increase more slowly in size than spindle-cell, and, judging from the statistics of the progress of the disease, cases of sarcoma of the stomach metastasize less rapidly than carcinoma, and the length of life after the appearance of the disease in non-operative cases appears to be longer than in carcinoma cases Therefore, operative results should afford a better prognosis than in carcinoma ventriculi

It would appear that a benign tumor, as a leiomyoma, may exist for years, grow slowly, and then become sarcomatous Kimpton reports such a case in a woman of thirty, in whom he resected the stomach for a round-cell sarcoma The patient stated that she first noticed the tumor when she was eleven years old

Metastases—While forming less rapidly than in carcinoma, metastases, when they do occur, are most frequently found in the lymph-nodes in relation to the stomach, and secondly in the liver, as occurs in carcinoma In only one of my three cases, Case I, were the glands involved, in which instance they were of considerable size, and of a consistency and appearance that made the operative diagnosis of sarcoma probable

Location of the Lesion—An analysis of 146 cases in which the location of the lesion was given, published by Flebbe in 1913, showed it to be located at the pylorus in 37, greater curvature, 30, posterior wall, 26, lesser curvature, 13, anterior wall, 8, cardia, 3, pylorus and both curvatures, 2, while in 27 cases almost the entire stomach was infiltrated

Symptomatology—As a rule, a previous history of gastric disturbance is absent in sarcoma of the stomach Pain is the most constant symptom and is present in most cases, but the amount of pain as with the other symptoms would appear to depend somewhat on ulceration Vomiting, and especially hæmatemesis, is less frequent than in carcinoma, and as the growth does not so often affect the pylorus, or even if in the pyloric region, is not as apt to cause stenosis as is carcinoma, the symptoms of pyloric obstruction are not so common Cachexia develops more slowly than in carcinoma, but anæmia is mentioned as a frequent symptom In none of my three cases was the latter of prominence The presence of an inflammatory leucocytosis has also been recorded Albumen in the urine is mentioned as one of the occasional symptoms This is explained by the presence of metastases in the kidney and therefore would not be a symptom of a stomach sarcoma, and if not due to coincident nephritis, would contraindicate operation When the growth is infiltrating a mass may not be felt, but in some of the infiltrating cases and many others a palpable tumor is present, especially in the case of exogastric tumors, which grow to a large size In one of my cases, although the tumor was of the infiltrating lymphosarcoma type, the mass formed by the enlarged glands could be palpated before operation Schlesinger states that an enlargement of the spleen is found in 10 per cent of the cases of sarcoma

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of the stomach, especially in lymphosarcoma, although this is not necessarily due to metastasis

The examination of the gastric contents in carcinoma usually shows the absence of free hydrochloric acid. This, while not absolutely diagnostic, is of aid in making the diagnosis. In sarcoma free hydrochloric acid is apt to be present, although frequently absent. In both of my cases in which a gastric analysis was done free hydrochloric acid was present in the expressed test meals. Blood in the stomach contents or stools is not as frequently found as in carcinoma. Occasionally cellular elements from the tumor may be found in the return from a test meal or gastric lavage which would indicate the presence of sarcoma.

Radiographic Examination—Although a positive diagnosis of sarcoma could not possibly be made by a radiographic examination, the X-ray is the greatest aid we have in making a diagnosis of the presence of an operative lesion. Deformity of the stomach, filling defects, irregularity of the outline, interference with the peristaltic waves, the relation of the stomach to an exogastric tumor, all point to a necessarily operative condition, which, after all, is the closest we can hope to come in the pre-operative diagnosis of most gastric disorders.

It has been suggested that an infiltrating tumor may be diagnosed by a fluoroscopic examination demonstrating the inability of pressure with the hand to indent the infiltrated stomach wall. Also where so large a portion of the stomach is shown to be infiltrated that operative cure is impossible, the careful radiographic examination can prevent unnecessary surgery in a hopelessly inoperable case. In two of my cases which were radiographed, a radiographic diagnosis of ulcer was made in one and of carcinoma in the other.

Cases Reported in the Literature—In the 150 cases reported by Ziesche and Davidsohn in 1909, the majority were from autopsy reports, there were 52 operative cases. Of these 31 were exogastric tumors. In 25 of these resection of the tumor was reported, 7 died as a result of operation, 11 recovered, but no subsequent report was made, while 7 were reported well three months to three years after operation. In the other 6 exogastric tumors, where operative procedure other than resection was resorted to, all died. Of 21 gastric tumors, 12 were resected and 5 died. Of 5 that recovered there were no subsequent reports and two were reported well, one case a year, and the other four years after operation.

In 9 gastric tumors in which resection was not performed, 4 being gastroenterostomies and 5 exploratory laparotomies, all died. Thus there were 37 resections of which 25 recovered, a mortality of 32 per cent.

Frazier, in 1913, reported 28 operative cases. Of these 11 correspond to Ziesche and Davidsohn's list of operations, one of them being an exploratory laparotomy. There are 17 additional cases in Frazier's list, 7 of which were reported subsequent to Ziesche and Davidsohn's paper. He does not include, however, 16 exogastric resections, 11 resections of gastric tumor,

and 14 cases, operated on by other methods than resection, in the list of Ziesche and Davidsohn. This makes a total of 69 operations and 54 resections up to 1913. It is of interest to report here that one of these patients in Frazier's list operated on by Moschowitz in 1909 died in 1919 of another disease with no signs of recurrence of the sarcoma. Kimpton has recently reported a case without recurrence five years and ten months after operation for round-cell sarcoma, and the case reported by Rupert operated on by Schopf was well fourteen years after operation. The most complete analysis of the largest number of cases that I have been able to find in the literature is that of Forni, published in 1914, who brought the list of reported cases up to 200. A complete bibliography is included in his report.

Since the report of this group of cases the following cases have been reported, or were not included therein:

HUNTINGTON Woman, aged 67 years, fibrosarcoma, size of cherry, originating in pyloric region. Resection of pylorus. Reported well two months later.

MAYO, W. J. Man, aged 38 years, resection of stomach for tumor size of head lying in pelvis. Recovery. Death in six months from recurrence.

MAYO, C. H. Man, aged 43 years, intrinsic myxosarcoma. Patient well at end of one year.

MEDINA AND EGANA Man, aged 37 years, fibrosarcoma of lesser curvature and posterior wall with pylorus intact. Resection, with anterior gastro-enterostomy. Patient well one and a half years later.

BARRINGTON, WARD Man, aged 25 years, round-cell sarcoma, size of fist, growing from pyloric region in stomach. Successfully resected.

FRITZESCHE Reports a case of sarcomatous leiomyoma of the stomach operated on by Quervain, which had perforated, the tumor originating from the greater curvature.

HARTZ Man, aged 41 years, round-cell sarcoma of the anterior wall and lesser curvature of the stomach. Exploratory laparotomy by Montgomery. Died sixteen days later.

KIMPTON Woman, aged 30 years. Multiple pedunculated round-cell sarcoma, involving pyloric end of stomach. Well five years ten months after resection.

SCHLESINGER Boy, aged 17 years, operated by Foderl. Lymphosarcoma of pylorus. Resection, recovery. Man, aged 32 years, lymphosarcoma of cardia and posterior wall. Extensive metastasis. Exploratory laparotomy. Man, aged 66 years, diffuse lymphosarcoma, involving middle of stomach between cardia and pylorus. Extensive metastasis. Exploratory laparotomy.

Seven cases are reported from autopsy records. Two by Warner, both of which were leiomyosarcoma, one from the greater curvature and the other from the pyloric region. One of fibromyxosarcoma, by Rohdenburg, and one of myosarcoma which weighed eleven pounds, by Pagenstecher. Two by Giacoma, one of which, a man aged 65 years, had a round-cell infiltrating submucous tumor forming several polypoid masses, the other a woman, aged 91 years, with a round-cell sarcoma infiltrating the pylorus. Saito reports the autopsy on a woman, aged 27 years, with an infiltrating tumor of the lesser curvature from the pylorus to the cardia, which showed mixed tissue elements of myxosarcoma and carcinoma cells, or a true carcinosarcoma.

In addition to these 18 cases, 7 cases from the literature not included in the list of Forni collected by Medina and Egana, and the 3 cases of resection reported by the writer, making a total of 228, there are articles and case reports noted in the Index Medicus for 1914 to 1919 by Burty,

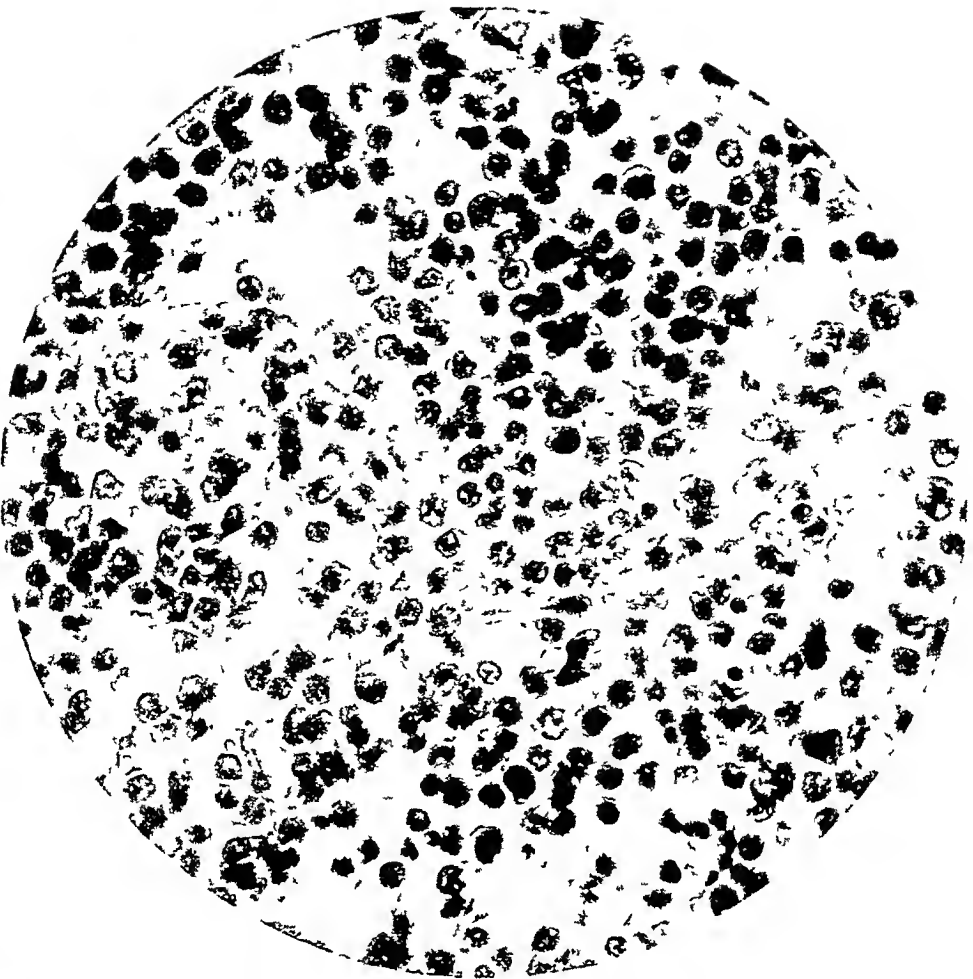


FIG 1—Case I Sarcoma of stomach Section through tumor X 600

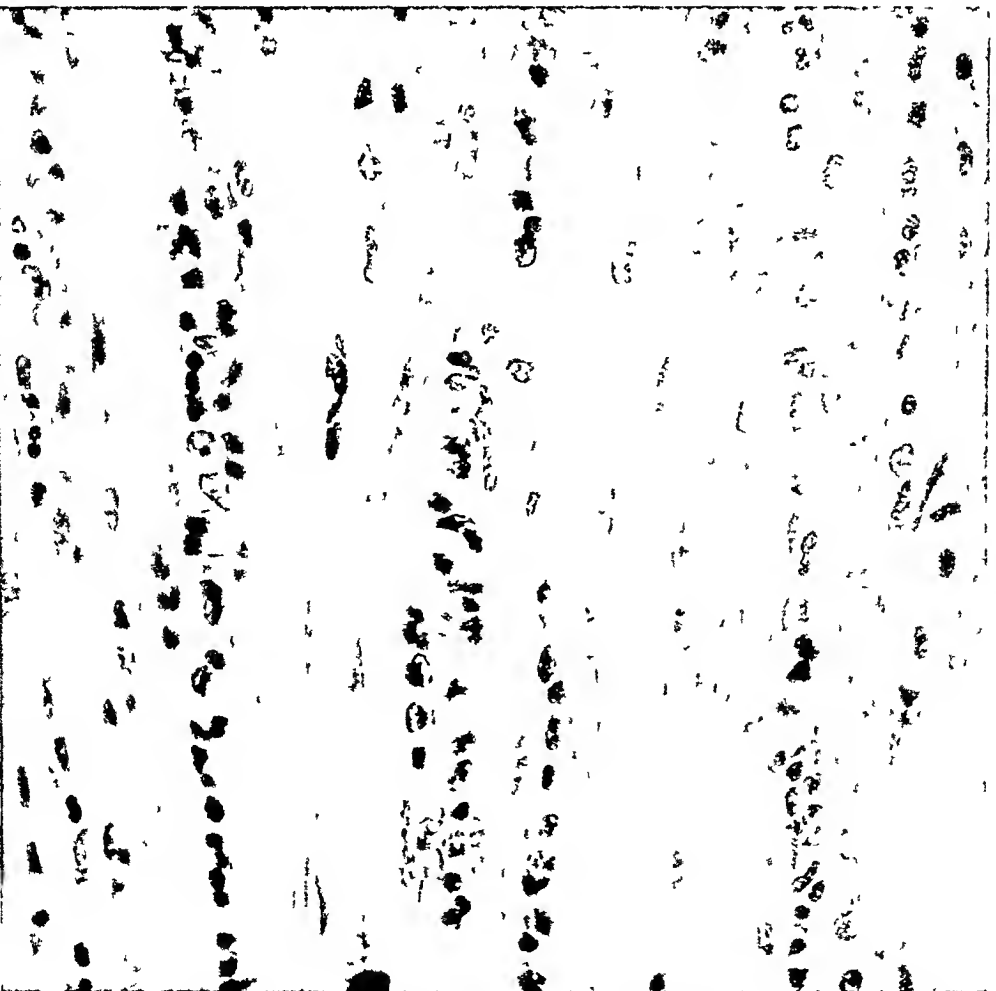


FIG 2—Case I Sarcoma of stomach showing infiltration of stomach walls with tumor cells X 600

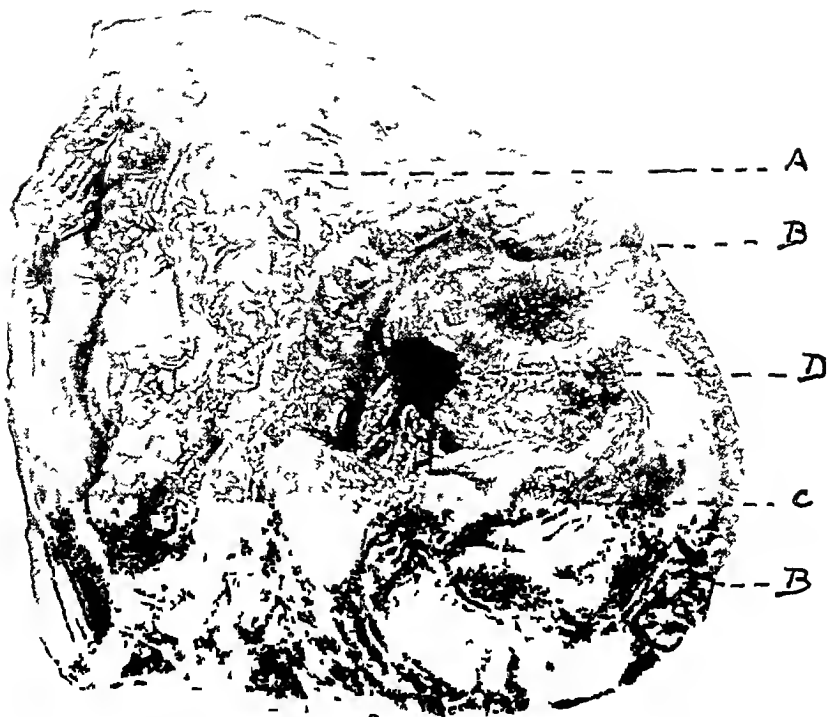


FIG 3 —Case III Section of stomach removed showing sarcomatous ulcer

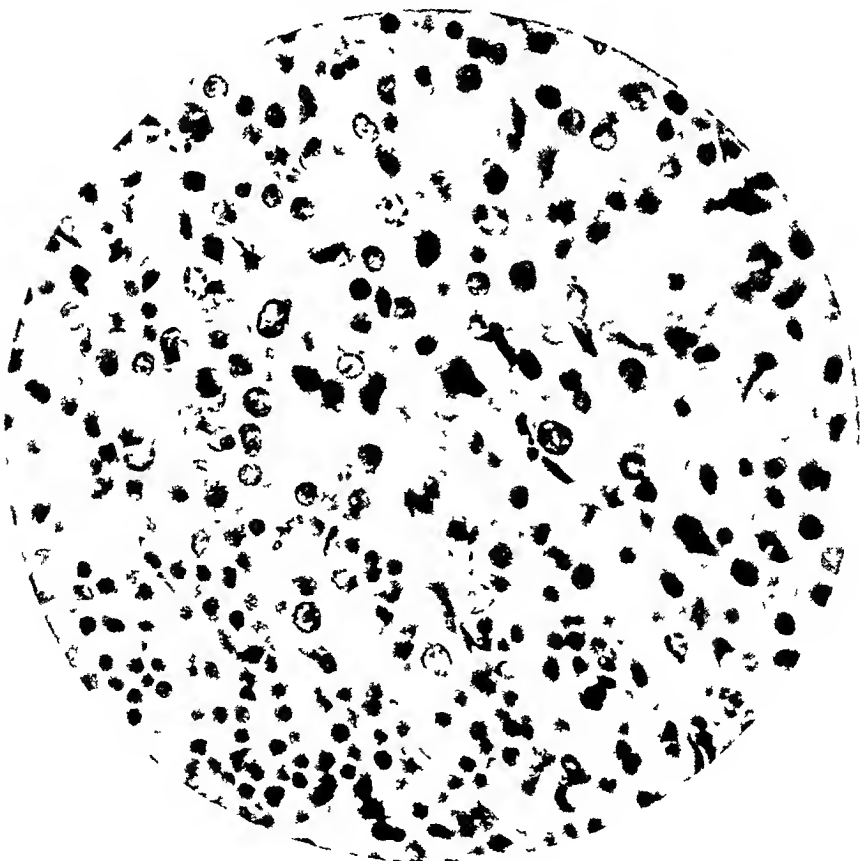


FIG 4 —Case III Sarcoma of stomach Section through tumor $\times 600$

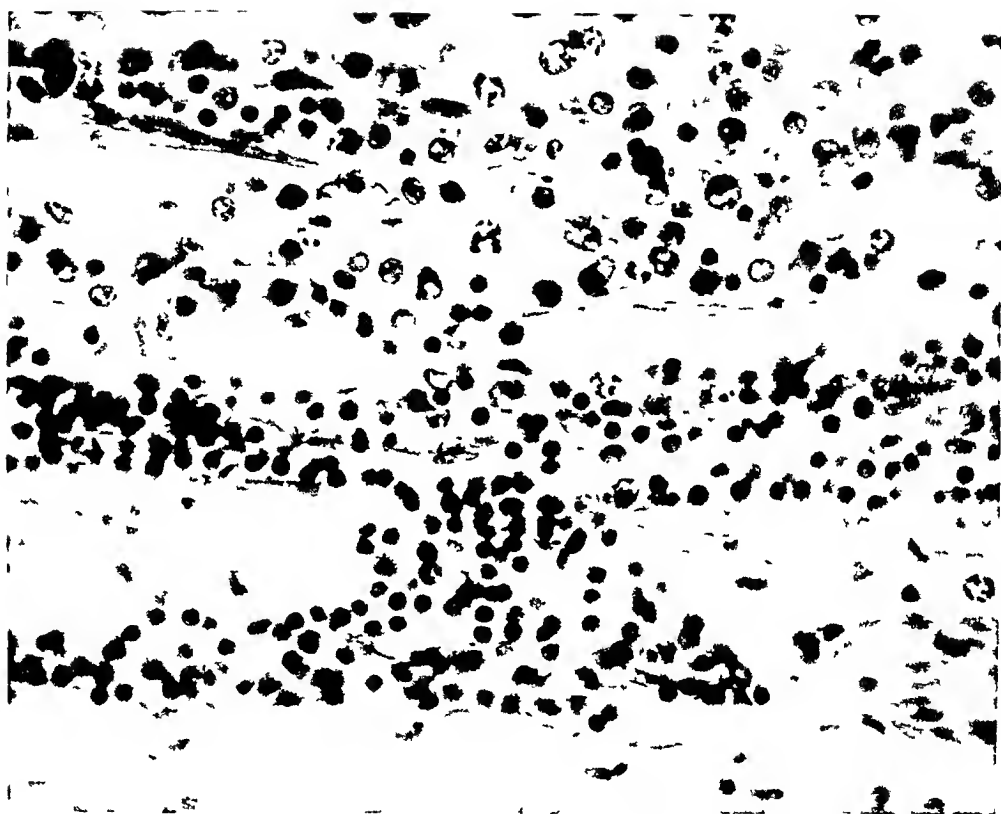


FIG 5 —Case III Sarcoma of stomach showing infiltration of stomach wall with tumor cells $\times 600$

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Geymuller, Hesse, and Koettlitz, but none of the journals containing these articles are at present obtainable at the New York Academy of Medicine. The articles by Burty and Koettlitz are each reports of one case, making 230 cases reported in all.

The following is a brief report of the three cases reported on by the writer of this paper.

CASE I—Woman, aged thirty-eight years, admitted to St. Luke's Hospital May 27, 1917. Had an appendectomy four years ago for symptoms of indigestion which were not relieved by the operation. Symptoms have been worse for past six months when she developed pain in the right hypochondrium made worse by eating.

Examination revealed an irregular mass in the right hypochondrium. No radiograph examination or gastric analysis was done as a preoperative diagnosis of cholecystitis was made. At operation the pyloric end of the stomach was found greatly infiltrated, the wall measuring 1.5 cm in thickness. There were a number of enlarged white lymph-nodes along the greater curvature, the largest of which was 2.5 by 2 cm in diameter. The pyloric third of the stomach was resected, an operative diagnosis of sarcoma being made. Operation was difficult on account of the large blood-vessels about the stomach and glands. The patient died of hemorrhage and shock the following day. "Examination of the specimen showed lymphosarcoma in the stomach and glands" (Figs 1 and 2) (Dr. F. C. Wood). Mucous membrane not ulcerated.

CASE II—Woman, aged forty-one years, admitted to Bellevue Hospital on July 24, 1917. Had been operated on one year previously for a gynecological condition. Had belched gas after meals for two years. Had lost 40 pounds in weight in last year. Pain in epigastric region and occasional vomiting for past few weeks. Gastric analysis after Ewald meal showed total acidity of 38. No free hydrochloric acid, lactic acid, blood or bile. After a Boas meal free hydrochloric acid was present. Urine examination, blood examination, and Wassermann negative. X-ray examination indicated the presence of ulcer of the pylorus. No mass could be felt.

At operation an infiltration of the pyloric end of the stomach was found. It was not adherent and the glands were not enlarged. A resection of the pyloric third of the stomach was done by the Billroth No. 2 method. The patient made a good recovery from the operation. She was allowed up in a chair sixteen days after operation with the wound healed, but she did not regain strength and vomited at times. Her mind was cloudy and the patient died twenty-three days after operation.

Pathological Diagnosis—Lymphosarcoma of stomach (Dr. Chas. Norris).

CASE III—Man, aged thirty-six years, admitted to Bellevue Hospital September 22, 1918.

Had been operated on in another hospital one year previously for varicose veins of the legs. No history of gastric disorder pre-

vious to three months before admission, when he began to have pain and distress in his epigastrium and right hypochondrium, at first in no relation to meals, later after eating. Did not vomit until two nights before admission. Had lost 15 pounds in weight.

Gastric Analysis—Total acidity, 22, free hydrochloric acid, 16, lactic acid, 0, urine, negative. Blood examination. Red blood-cells, 4,422,000, hæmoglobin, 78 per cent, white blood-cells, 11,000, polynuclear cells, 77 per cent.

X-ray examination revealed a marked deformity of the stomach, a diagnosis of perforating carcinomatous ulcer being made.

At operation a large callous ulcer of the posterior wall was found which had perforated and was adherent to the pancreas (Fig 3). There were no enlarged glands. The stomach was separated from the pancreas with difficulty and resection of one-third of the stomach by the Billroth No 2 method was done. Examination of the specimen showed lymphosarcoma (Figs 4 and 5) (Dr Douglas Symmers). The detailed report by whom is here given.

"Microscopic examination of the stomach shows the presence of extensive necrosis of the mucous membrane. The muscular wall is enormously infiltrated and destroyed by cells, some of which are the type of small lymphocytes, but most of which are apparently large lymphocytes.

"Assuming that the blood was examined during life and that no evidences of lymphatic leukæmia were detected, the best interpretation of the histological findings would appear to be that of a growth belonging in the category of the lymphosarcomata.

"In this connection it is interesting to recall that the stomach is occasionally the seat of a growth of similar histological appearances which, after the lapse of a certain length of time, suddenly commences to pour its cells into the blood stream, constituting a true leukæmia. The latter phenomenon is rapidly followed by death. This is the so-called leucosarcoma of Sternberg. It is possible that this case is an example of this lesion. It is likewise interesting to note that there are varieties of lymphosarcoma which, after attaining relatively enormous proportions, undergo involution and disappear either spontaneously or under the influence of such applications as radium or the X-ray. Thus the lymphosarcomata vary greatly in malignancy."

The patient made an excellent recovery and has no symptoms of recurrence sixteen months after operation.

SUMMARY

Sarcoma of the stomach occurs in 1 per cent of all stomach tumors. The average age of incidence is 41.6, in contrast with an average age of 61.2 for carcinoma. The average age for lymphosarcoma is earlier than in the other forms.

Round-cell and lymphosarcoma are the most frequent forms found. They are more apt to be infiltrating, but the round-cell may project into

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the stomach or form pedunculated tumors. They result in ulceration oftener than in other sarcomata, but not as frequently as in carcinoma. Spindle-cell and myosarcoma are apt to form large exogastric tumors. While statistics show that the most common site is in the region of the pylorus, especially in the infiltrating form, other portions of the stomach are more frequently involved, and the pylorus itself is less often attacked or obstructed than in carcinoma. Metastasis also occurs less rapidly than in the latter, and the operative prognosis should therefore be better.

The diagnosis can rarely be made with certainty, the X-ray examination furnishes the most useful evidence. When in the presence of a tumor in a patient younger than those in which cancer is usual a short history of gastric disturbance, absence of blood in the gastric contents and stool, and the presence of free hydrochloric acid, the absence of cachexia, and the presence of anæmia, while not ruling out cancer, ulcer, or syphilis of the stomach, may cause the diagnosis of sarcoma to be considered.

The total number of authenticated cases now recorded is brought up to 230 with a probable larger number on record, the reports of which are not now available. To the number of operative cases, in addition to the 69 previously reported in the lists of Ziesche and Davidsohn and of Frazier, may be added the 8 cases from the literature collected by Medina and Egana, one case in this list being reported by Forni, but not included in the operative list, one case by Forni, the additional 11 reported in this paper, and the 3 cases of the writer, a total of 92 operative cases, of which 69 were resections either of the exogastric tumor or of part of the stomach and 23 were either gastroenterostomies or exploratory laparotomies.

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HYPERPLASTIC TUBERCULOSIS OF THE INTESTINES*

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THE abdominal surgeon encounters tuberculosis in various forms with moderate frequency

The serous form of tuberculous peritonitis is not uncommon and is often surprisingly benefited by laparotomy with the removal of the vermiform appendix or Fallopian tube, which may be found to be the focus of infection

In plastic or sero-fibrinous tuberculous peritonitis, however, and in ulcerative entero-peritoneal tuberculosis, where interference may be necessary for the relief of intestinal obstruction or fecal abscess, the prognosis is much less favorable, for the disease is likely to continue its progress and the obstruction to recur, despite an operation, which may have consisted in mere separation of adhesions, or a side-tracking anastomosis or a resection

Tuberculosis, limited to the Fallopian tubes or to the appendix, is occasionally found at operation upon those organs and their early excision may prevent the development of a generalized tuberculous peritonitis. In these cases the diagnosis is frequently made by the pathologist

The form of tuberculosis with which we are to deal in this paper is the chronic hyperplastic tuberculosis of the intestines, which, although comparatively rare, affords an interesting field for radical surgery

From its seat of election it has been variously designated as "ileo-cæcal tumor" (Duranti), "typhilitis resembling cancer" (Hartmann), "the real surgical tuberculosis of the cæcum" (Berard)

Factors which constitute indications for surgery in this condition and which at the same time definitely influence the results obtained are the slow growth of a painless tumor, with a strong tendency to stenosis and to chronic obstruction, the limited area of involvement, permitting of excision, the attenuation of the tuberculous infection in the lesion and the comparative freedom from association with active pulmonary tuberculosis

Of the six cases of chronic hyperplastic tuberculosis of the intestines recorded below, five occurred in the service of the Second Surgical Division of the New York Hospital, and are published by the courtesy of Dr Eugene H Pool, chief of service, and of Dr F W Bancroft, whose operative cases are included in this report

The sixth case was operated upon by the writer at Bellevue Hospital in 1913, and the patient was shown before the Surgical Section of the New York Academy of Medicine, March 4, 1914

CASE I—*Chronic hyperplastic tuberculosis of the cæcum* *Operation* *Resection of the cæcum* *Side-to-side ileo-colostomy* *Recovery*
Mohammed B Hindu from East Indies, aged 20 years Tailor

* Read before the New York Surgical Society, February 6, 1920

Admitted to the New York Hospital, April 22, 1918 Discharged May 14, 1918

Chief complaint Cramp-like pains in right lower abdomen

Past history Denies any previous illness

Venereal history is negative

Present illness This began 2½ months ago with cramp-like pains centering about the umbilicus and later localized in the right lower quadrant There was no vomiting, constipation nor diarrhoea

After a few days the pains passed away and the patient has felt well until four days ago,

Four days ago there occurred a similar attack of severe cramping pain, at first general, and later localized in the right lower quadrant, with constipation, but without vomiting No urinary symptoms

Physical examination on admission showed an undernourished young Hindu who did not appear acutely ill Temperature, 100° F, pulse, 88, respiration, 22

Lungs showed signs of old inactive tuberculosis at both apices

Abdomen was thin walled and not rigid In the right lower quadrant was palpable a firm, oval, slightly tender mass in the region of the cæcum and slightly movable laterally

Admission diagnosis Subacute appendicitis

Operation by Dr Seward Erdman, April 23, 1918 Right rectus incision No free fluid was encountered, nor was there the appearance of any acute inflammatory process The appendix and the cæcum proper were moderately thickened, but the ascending colon from the level of the ileo-cæcal valve nearly up to the hepatic flexure was very markedly thickened, tumefied and with a dull red, roughened serosa presenting tiny elevations which resembled tubercles

The external diameter of the colon was slightly larger than normal, but the great thickening of the walls caused an almost complete occlusion of the lumen

The mesenteric lymph-nodes adjacent were enlarged to the size of from 1 cm to 2.5 cm in diameter

Elsewhere in the abdomen the intestines and the peritoneum appeared and felt normal

The cæcum was then resected, including three inches of ileum and the ascending colon up to the hepatic flexure, and a side-to-side ileocolostomy performed, using the transverse colon

Pathological Report—Tuberculosis of cæcum Mucosa of cæcum at orifice of appendix presents an ulcer area 4 cm in diameter The walls of the cæcum are very much thickened and contain tubercles

Post-operative Notes—Convalescence was very smooth There was slight superficial wound drainage and the patient went home on the twentieth day after operation Weight on discharge was 95 pounds

Follow-up Notes—At eighteen months after operation, the patient is working as usual and in better physical condition than when he was in the hospital He has no complaints and the bowels are regular, daily

At twenty-two months after operation, he remains perfectly well and has gained over 15 pounds in weight

CASE II—*Chronic hyperplastic tuberculosis of ileum and cæcum*



FIG. 1—Case II Hyperplastic tuberculous of ileum caecum and rectum Barium enema shows filling defect of rectum suggesting neoplasm



FIG 2—Case III Hyperplastic tuberculosis of sigmoid after barium enema showing filling defect in sigmoid suggestive of neoplasm

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Stricture of rectum Operation Resection of cæcum and 16 inches of terminal ileum Ileo-sigmoidostomy Left inguinal colostomy. Died in hospital

Benjamin W, Austrian, aged thirty-two years Admitted to the New York Hospital, November 5, 1917 Died November 23, 1917

Chief complaint Cramp-like abdominal pain Bloody diarrhœa

Past history In 1910 was operated upon for hemorrhoids at another hospital, but an ulcerated condition was found

In 1911, at another hospital, a temporary right inguinal colostomy was performed, to permit irrigations of the colon with silver nitrate solutions

Venereal infection is denied and the Wassermann is negative

Present illness About seven months ago he began to suffer from severe cramping abdominal pain, coming on immediately after food and lasting about an hour Also there occurred profuse diarrhœa, 15 to 20 stools a day, with mucus and occasionally blood Loss of weight is estimated at 20 pounds in the past seven months

Physical examination on admission Temperature, 100°, pulse, 100

Lungs reveal signs of an old tuberculous process at the left apex

Abdomen There is a small incisional hernia at the site of the healed colostomy wound in the right lower quadrant

Rectal examination shows hemorrhoids and higher up a partial stricture of the rectum

Stool examinations in the hospital did not show any blood

X-ray examination after a barium enema revealed a filling defect of the lower sigmoid and rectum, suspicious of a neoplasm (Heredeen) (Fig 1)

Operation by Dr F W Bancroft, November 14, 1917

Right papamedian incision in lower abdomen

The terminal ileum and the cæcum were found very markedly thickened and the lumen much diminished

The cæcum and about 16 inches of terminal ileum were resected and an ileo-sigmoidostomy was performed, to which was added the first stage of a left inguinal colostomy below the anastomosis, for the purpose of better drainage on account of the rectal stricture

This sigmoid loop was opened with the cautery forty-eight hours after operation

Pathological Report—Chronic tuberculosis of the intestine

Post-operative Notes—There was considerable shock Drainage was profuse There were signs of peritoneal irritation, hiccough and vomiting, and the patient died on the ninth day after the operation No autopsy

CASE III—*Chronic hyperplastic tuberculosis of sigmoid Chronic ulcer of rectum and hemorrhoids Operation Exploratory laparotomy Hemorrhoidectomy Improved*

Peter McE, U S, aged twenty-nine years Admitted to the New York Hospital, May 18, 1917 Discharged, improved, June 2, 1917

Chief complaint Pain in lower abdomen Diarrhœa

Past history No previous illnesses

Venereal disease denied and blood Wassermann negative

Present illness dates from four months ago, when he began to suffer from constipation, hemorrhoids and bloody stools, associated with occasional dull pains in the left lower quadrant of the abdomen

Five days ago, after lifting a heavy weight, he felt "dizzy and heavy" and had diarrhoea with nausea, but no vomiting. There was dull pain in the lower abdomen and general weakness.

Physical examination on admission: Temperature, 100.8° F, pulse, 86. Lungs, negative.

In the abdomen there was palpable a sausage-shaped mass about 10 x 5 cm in diameter in the left lower quadrant, which was slightly movable. There was no great tenderness and no rigidity.

Rectal examination showed a moderate hemorrhoidal condition and a small ulcer about 1 cm in diameter, just above the sphincter ani.

X-ray examination after a barium enema showed a filling defect which was regarded as suspicious of a new growth of the sigmoid (Busby) (Fig 2).

Operation by Dr Seward Erdman, May 23, 1917. Exploratory laparotomy.

The general abdominal cavity was free from pathology, but a segment of the lower sigmoid about 10 cm in length was found deeply congested in appearance and with pronounced thickening of its walls.

This thickening was symmetrical and involved the entire circumference of the bowel. The serosa over it had the sand-paper appearance suggestive of tuberculosis.

The lumen was only slightly encroached upon. There was no sign of ulceration, neoplasm or diverticulitis.

The mesenteric lymph-nodes adjacent were enlarged and one was removed for examination.

The abdomen was then closed.

The hemorrhoids were then excised, together with the soft ulcer of the rectum.

Pathological Report—Sections of the ulcer of the rectum showed only chronic inflammation. The mesenteric lymph-node was, unfortunately, lost and not examined.

Post-operative Notes—The wound healed per primam and the patient went home on the tenth day after operation.

Follow-up Notes—Eighteen months after operation patient is very well and working and has gained 20 pounds in weight. He is constipated and has occasional pains in abdomen.

CASE IV—*Chronic hyperplastic tuberculosis of the cæcum. Operation. Resection of cæcum and 20 cm of terminal ileum. End-to-side ileo-colostomy. Recovery.*

Rosie M., Italian woman, aged forty-two years. Admitted to the New York Hospital October 20, 1919. Discharged improved, November 21, 1919.

Chief complaint: Pain in right lower abdomen with vomiting.

Past history, as obtained through interpreter, was negative as to past illnesses. Has had four normal confinements.

Venereal history and blood Wassermann negative.

Present illness began three months ago with the gradual onset of

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increasing constipation, epigastric pain not radiating and with flatulence
Gradual loss of weight and strength No blood in stools

One month ago had a more severe attack of pain with nausea and vomiting and was thought by her physician to have appendicitis

Three days ago she had another attack of sharp pain in the right side of the abdomen with vomiting

Physical examination on admission Temperature, 98° F, pulse, 80, leucocytes 10,200, with 70 per cent polynuclears, hæmoglobin, 72 per cent

The lungs gave no definite physical signs of tuberculosis but the X-ray of the chest was suggestive of pulmonary tuberculosis

The heart showed a mitral stenosis

Abdominal examination revealed a readily palpable rounded nodular mass in the region of the cæcum, only slightly tender, and which could be swung from side to side Owing to the thinness of the abdominal walls, this tumefaction was visible at times, as was also peristalsis

X-ray examination after a barium enema showed that the cæcum did not receive the injection and there was the appearance of gas at the hepatic flexure

Operation by Dr E H Pool, October 22, 1919, for ileo-cæcal tuberculosis Right rectus incision There was no increase of free fluid and the intestines and peritoneum seemed normal everywhere except in the cæcum

The cæcum was the site of a firm, almost hard, rounded, nodular mass about 8 cm in diameter, which very closely simulated a carcinoma, even when inspected after removal

The cæcum and about 20 cm of the ileum were resected and an end-to-side ileo-colostomy performed into the transverse colon

Pathological Report—Tuberculosis of the cæcum, with much chronic productive inflammation and scattered tubercles

Post-operative Notes—There was considerable drainage from the wound but the convalescence was satisfactory and the patient left the hospital in good condition, four weeks after operation

February 6, 1920, this patient is shown by Doctor Pool before the New York Surgical Society, in good physical condition and without symptoms

CASE V—Chronic hyperplastic tuberculosis of ascending colon Tuberculosis of peritoneum Operation Cæco-colostomy by lateral anastomosis Temporary improvement Died about 4 months after operation

Lena R, Russian woman, aged twenty-seven years Admitted to the New York Hospital, August 16, 1919 Discharged improved, September 1, 1919

Chief complaint Cramp-like pain in the right lower quadrant

Past history of constipation for a number of years Has had no serious illnesses Has had several children and at present is nursing her three-month-old baby

Present illness began two weeks ago with sudden cramp-like pain in the right lower quadrant of the abdomen, non-radiating Constipation has been obstinate and she has vomited

Physical examination on admission Temperature, 98.4° F , pulse, 84, leucocytes 6000, with 50 per cent polynuclears

Heart and lungs clear

Abdomen soft, relaxed Cæcum feels as if dilated and filled with fæces, but is partially reducible on massage, with the accompaniment of much gurgling and borborygm

Operation by Dr F W Bancroft, August 18, 1918 Upon opening the abdomen much straw-colored free fluid was encountered and everywhere the peritoneum was studded with tubercles

On the ascending colon near the hepatic flexure there was a large, hard, nodular mass formed by the great thickening of the walls of the bowel, and encroaching on the lumen so as to cause partial intestinal obstruction

On account of the patient's poor general condition and because of the complicating tuberculous peritonitis, resection was considered inexpedient

A side-tracking anastomosis was performed by means of a lateral anastomosis between the cæcum and the transverse colon

The appendix vermiformis was removed, and the wound closed

Pathological Report—Chronic inflammation of the appendix

Post-operative Notes—The convalescence was very easy and the patient left the hospital improved on the fourteenth day after operation

Follow-up Notes—Six weeks after operation the patient was readmitted to the hospital suffering with symptoms of chronic intestinal obstruction, with abdomen distended and of doughy consistency

X-ray examination after a barium meal showed evidence of much kinking and adhesions in the small intestines

The patient went home without operation and rapidly lost ground, and died about four months after operation

CASE VI—Chronic hyperplastic tuberculosis of ileum Enteroperitoneal tuberculosis Perforated ulcer Operation Resection of 15 cm of ileum Ileo-colostomy Recovery

Ellen V, Greek woman, aged twenty-six years Admitted to Bellevue Hospital June 25, 1913 Discharged improved, August 11, 1913

Chief complaint Pain in right lower abdomen with vomiting

Past history Was well until two years ago, when after her arrival in America, she began to lose weight and strength Has had no definite pulmonary symptoms Her appetite and bowels are normal

Present illness began two months ago with an attack of moderately severe pain in the right lower quadrant of the abdomen with nausea and vomiting

Similar attacks have occurred several times in the past two months, the last one beginning four days ago

For four days she has been confined to bed No blood in stools

Physical examination on admission Temperature, 101° F , pulse, 96, respiration, 24, leucocytes, 21,000, with 80 per cent polynuclears

Heart and lungs negative

Abdominal examination reveals a palpable mass in the right lower quadrant, which is moderately tender and fixed

Operation by Dr Seward Erdman, June 27, 1913 Right rectus in-

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cision A mass the size of a fist was found in the right inguinal region made up of matted loops of terminal ileum and cæcum, forming the walls of a fecal abscess at the site of a perforated tuberculous ulcer in the lower ileum

For several inches distal to the perforation, the ileum was very much thickened and the lumen almost completely occluded

The appendix vermiformis also was much thickened, but the cæcum was nearly normal

About 15 cm of the diseased ileum were resected and a side-to-side ileo-colostomy performed, using the transverse colon

The appendix also was removed

Pathological Report—Chronic tuberculosis of the ileum and appendix The section of ileum presented a perforated ulcer, and distal to this there was very marked diffuse tuberculous hyperplasia of the walls

Post-operative Notes—There was considerable drainage from the wound but it was never fecal The patient was discharged improved, six weeks after operation

Follow-up Notes—The wound was finally completely healed in three months after operation

Nine months after operation, the patient was shown before the Surgical Section of the New York Academy of Medicine in very fair general condition Soon after this time she returned to Greece and has not been heard from

Tuberculosis of the intestines is encountered in four different types, according to the classification of the French school

1 The ulcerative type, or tuberculous enteritis, which is a common and often primary lesion in children, also occurs as a secondary lesion in adults with advanced pulmonary tuberculosis (Weigert asserts that it is found in 90 per cent of advanced tuberculosis)

This type is not generally regarded as a field for surgery, although E Archibald, of Montreal ("American Review of Tuberculosis," Baltimore, 1917), does advocate operation in many of these cases and reports a series of cases, some of which were benefited by resection or by side-tracking anastomosis

2 The cicatricial or stenosing type This results from contracture of the completely healed ulcer and produces a narrow fibrous stricture, giving the appearance of a ligature tied about the bowel Its site is usually in the small intestine, and it may be multiple When present in the large intestine, it never causes real obstruction, but at most only a shelf-like projection into the lumen

3 The entero-peritoneal type selects the ileo-cæcal region and it combines ulceration with hyperplasia of the intestinal wall, and further, it involves the adjacent peritoneum, mesentery and lymph-nodes It forms a tumor by the matting together of loops of bowel, and fecal abscess resulting from perforation of an ulcer is not uncommon Occasionally a spontaneous entero-enterostomy takes place between adjacent loops of intestine

4 Chronic hyperplastic tuberculosis, which according to Hartmann con-

stitutes 85 per cent of all tuberculosis of the intestines in adults, is the fourth type. It is essentially a disease of the cæcum but is also found in the terminal ileum, the flexures of the colon and in the rectum.

In our series of cases, the first four were of the hyperplastic type, the fifth combined the hyperplastic type with general tuberculosis of the peritoneum, and the sixth case combined the hyperplastic with the entero-peritoneal type.

The distinctions between these four types are not always sharply drawn.

Etiological Factors—Age. In our series of cases of chronic hyperplastic tuberculosis of the intestines the average age was just under thirty years, which is in harmony with the statement that it is most common between twenty and forty years. This fact is of some weight in differentiating tuberculosis from carcinoma.

Whether ileo-cæcal tuberculosis may be primary or whether it is always secondary to pulmonary tuberculosis is a question upon which opinions vary.

Cumston says that "the hyperplastic type is usually, one might say always, primary."

Hemmeter believes that it is always secondary to pulmonary tuberculosis.

That tuberculous infection may occur primarily in the intestinal tract is supported by incontestable autopsy evidence, and although comparatively rare in the adult (i.e., from 1 to 3 per cent), it is so found in from 17 per cent to 37 per cent (Heller) in infants and young children, but here the usual lesion is either tuberculous entero-colitis or tuberculous peritonitis and not the hyperplastic type.

The greater frequency in childhood has been attributed to the ingestion of milk from infected cows, to the habit of picking up contaminated objects and putting them into the mouth, but probably still more important is susceptibility to entero-colitis and acute infectious diseases which may leave a receptive mucous surface.

August J. Lartigau, in 1901, in a very thorough study of a case of hyperplastic tuberculosis, with most exhaustive autopsy, was convinced that the intestinal lesion was primary in his case.

In our own series of six cases, four had definite signs of pulmonary tuberculosis, although in no case was the lesion found to be very active.

With the aid of the X-ray examination of the lungs, it is probable that a pulmonary lesion will be more frequently recognized.

The mode of infection may be either indirect, where the bacilli are borne by the blood or lymph from a lesion elsewhere, the lungs or the mesenteric lymph-nodes, or direct, through the mucosa from ulcers on its surface.

This direct method may apply not only to the primary cases but also to those which are secondary to pulmonary tuberculosis where sputum, laden with tubercle bacilli, is often swallowed by the patient.

Food stagnation with attendant injury to the mucosa must be a factor of real determining import in the hyperplastic type, for this form is found in the three areas of stagnation, to wit, lower ileum, cæcum and rectum.

HYPERPLASTIC TUBERCULOSIS OF THE INTESTINES

Pathology—The characteristic pathology of the hyperplastic tuberculosis is that of a massive thickening of the intestinal wall, especially involving the submucosa and the subserous layer. It represents the peculiar reaction of the lymphoid tissues against tubercular toxins of a lessened virulence.

The slow-growing, nodular tumor, situated usually in the right iliac fossa, may attain a size of from 8 to 20 cm in diameter.

Its consistency is hard and presents a bossed surface, so that macroscopically it may very closely simulate carcinoma.

The tendency is to stenosis and chronic obstruction, due to encroachment on the lumen by the greatly thickened walls.

The appendix vermiformis often remains free from the tuberculous process, but it is usually buried in adhesions.

Frequently there is an adherent envelope of sclerosed adipose tissue (Hartmann and Pilliet), and upon raising this envelope the cæcum becomes visible, enlarged, indurated, dull red and vascular, but in general preserving its shape.

Tubercles are few and scattered or may be entirely absent. Usually the whole circumference of the cæcum is involved.

The mucosa is thickened, with uneven surface and polypoid projections, and except very early, or in rare cases, ulcers are found.

The submucosa is the seat of the earliest and greatest hyperplasia and tubercles and giant cells are most frequently found here.

The muscle coats are little affected or appear hypertrophied by infiltration with connective-tissue cells.

The subserous layer, like the submucosa, is markedly thickened and the great increase of fibrous tissue here contributes largely to the rigidity of the mass.

The peritoneum overlying is much thickened and reddened and the mesenteric lymph-nodes are practically always enlarged.

The stenosis is rarely annular but more often cylindrical or funnel-shaped and the cavity of the cæcum may be almost obliterated, in general, the obstruction is dependent on the length and tortuosity of the diminished lumen.

Complications may develop later in the disease, and among these tuberculous peritonitis is at all times a danger, perforation may occur above the stenosis (as in our Case VI).

Acute obstruction is very rare, as is also intussusception.

Fistula formation or entero-anastomosis may follow perforation.

General miliary tuberculosis may supervene, or a sepsis from mixed infection.

Symptoms—The onset of the disease is slow and insidious, and it is estimated that it is usually from one to three years before the gradually increasing stenosis directs attention to the local lesion and leads the patient into the hands of the surgeon.

Early symptoms are indefinite gastro-intestinal disturbances, frequently with alternating constipation and diarrhœa.

Fever is usually absent and loss of weight and strength only occur late in the disease, unless due to pulmonary or other complications

Pain marks the beginning of real stenosis and assumes a violent colicky character following the ingestion of food, sometimes immediately, but more commonly after an interval of two to three hours

The pains last from one to several minutes and may be repeated many times during the process of digestion, and are usually referred to the right lower quadrant, whence they radiate across the abdomen

"Ballooning of the intestines, visible peristalsis, clapotage, boiborygmi, accompanying the colic and with the appearance of an elongated tumefaction, make up the syndrome of Koenig"

Vomiting is rare and never fecal, the stools occasionally show occult blood, and more rarely tubercle bacilli and pus

In our series of cases the average duration of symptoms noted by the patient was only three months, and in each case this probably corresponded with the development of the definite stenosis

Diagnosis—Carcinoma of the cæcum is very frequently confused with hyperplastic tuberculosis and the differential diagnosis may finally have to rest with the pathologist

Lartigau believes that some of the earlier reports of resection of the cæcum for carcinoma, with no recurrence, have in reality been cases of hyperplastic tuberculosis

In such a differential diagnosis the main supports of a diagnosis of hyperplastic tuberculosis will be the earlier age of the patient, the slower growth and longer course (two to three years), absence of cachexia until late, lower leucocyte count, evidence of tuberculosis in the lungs or elsewhere, and rarely tubercle bacilli in the stools

Appendicitis, subacute, or fibrinous or with abscess, is the diagnosis strongly suggested in those cases which give only a brief history of a few weeks, with pain in the right side, vomiting and palpable mass. In our series this was the diagnosis of the admitting physician, in three out of the six cases

Diverticulitis or carcinoma of the sigmoid may be the provisional diagnosis in those cases of hyperplastic tuberculosis of the sigmoid

Chronic intussusception, impacted feces, fibroma, sarcoma and actinomycosis must also be considered in making the diagnosis. As an aid in diagnosis the X-ray of the intestinal tract is of great value in locating the lesion, its extent, and in showing the amount of stenosis

In the hyperplastic type, the X-ray picture is that of a filling defect which, however, cannot be differentiated from neoplasm

In Case No. 4 of our series, the significant feature in the X-ray plate taken after the barium enema is the inability of the barium to enter the ascending colon and cæcum, for it met its obstruction at the hepatic flexure

Recently, however, Pirie, also Lawrason Brown, have shown that even without real stenosis, *i e*, in simple ulcerative tuberculous colitis, filling defects are to be observed in the diseased areas

HYPERPLASTIC TUBERCULOSIS OF THE INTESTINES

Brown states "that in all stages (of ulcerative tuberculous colitis) the barium meal shows shadows which determine definitely the presence of colonic ulcers, the X-ray picture is due to hypermotility and spasm or filling defects, such a picture in a patient with pulmonary tuberculosis denotes tuberculous colitis"

In our series of six cases, the location of the lesion of hyperplastic tuberculosis was Ileum (alone), one case, ileum and cæcum, one case, cæcum or ascending colon (alone), two cases, cæcum and rectum, one case, sigmoid, one case

Treatment—The treatment is definitely surgical as soon as the diagnosis is established, which usually means that stenosis is already present, and the earlier the intervention, the better the prospect of a radical cure

Radical resection of the diseased area is the operation of choice with appropriate intestinal anastomosis

In the usual location, ileo-cæcal, the operation will consist in resection of the cæcum and as much of the ileum as may be necessary and the performance of an ileo-colostomy, using the transverse colon, by preference, and a side-to-side anastomosis

When the patient's general condition prohibits a radical excision, or where the local technical difficulties are too great, some other surgical expedient must be used to overcome the obstruction, but none of these is really curative

1 Partial exclusion is the simplest and safest procedure as a palliative treatment and consists in a simple side-tracking lateral anastomosis between afferent and efferent loops of intestine, such was the procedure of choice in Case V of our series

2 Unilateral exclusion affords more complete rest to the diseased area

3 Bilateral exclusion has obvious disadvantages, even if a colostomy be performed in the isolated segment to permit of its proper drainage

4 An artificial anus in the afferent loop must be considered only as a measure of last resort

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THE RESULTS OBTAINED IN THE TREATMENT OF CHRONIC ARTHRITIS BY THE REMOVAL OF A DISTANT FOCUS OF INFECTION

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THE term focal infection in the last decade has become a byword in most of the clinics of this country. A focal or confined infection is an infectious process confined to some organ or tissue constantly maintaining bacteria of greater or less virulence. From this focus bacteria or toxins may be absorbed which produce disease processes, either local or general, in some other part of the body.¹

The teeth, the tonsils, the genito-urinary tract, the sinuses, the bronchi, the gall-bladder, the gastro-intestinal tract, the pancreas and the vermiform appendix are the usual locations for such foci.

The organisms most frequently found in such foci are the streptococci, gonococci, staphylococci and pneumococci.

The disease processes which are believed to be due to these foci of infection are numerous, namely, chronic arthritis,² nephritis,³ gastric ulcer,⁴ herpes zoster,⁵ endocarditis,⁶ myocarditis,⁷ pancreatitis,⁸ iritis,⁹ skin diseases,¹⁰ diabetes,¹¹ hyperthyroidism,¹² septicæmia,¹³ and many others.

In many of the later diseases, the relation to infection is of rather recent origin, while the relation of arthritis to infection is comparatively old.

Bradford,¹⁴ in 1883, had three cases of so-called rheumatic arthritis of the spine. Two of these had a gonorrhœal history. Schuller,¹⁵ in 1892, found organisms in cut sections of tissues, which he described in 1893.¹⁶ In 1896¹⁷ he described a quick method for demonstrating organisms in human tissues.

Poynton and Paine,¹⁸ in 1900, described a focal infection, as a localization of infection with outpouring of toxins which causes carditis, arthritis, nodules and other lesions.

Coincident with the theory of focal infection has arisen the idea of eradication of the foci, and thus checking or curing the disease.

This paper deals with the results obtained in the treatment of chronic arthritis by the removal of foci of infection.

Few accurate reports have been made of the results of this method of treatment. Billings¹⁹ reported a series of 10 cases of chronic arthritis, treated by the removal of foci of infection. Eight of these gave excellent results. In two of the very advanced cases the streptococci obtained from the foci, when injected into rabbits, produced an acute arthritis, either single or multiple.

Billings,²⁰ again in 1913, reported 70 cases of the so-called deforming type of arthritis. Although he gave no definite percentage as to the number

in which good results were obtained, he stated that in those patients in whom no marked destruction of tissue had occurred, recovery took place in many, and others were at the time convalescing. He also stated, that patients with bone and cartilaginous disease had vastly improved, and that the progress of disease apparently had been checked.

Ivy²¹ reported 8 cases of so-called arthritis deformans occurring between the ages of twenty-five and fifty years. In all these cases the focus was situated in the teeth. Root extraction and treatment of the pyorrhœa was followed by marked results in six of the cases.

Crowe, Watkins and Rothholz²² removed the tonsils in many cases of infectious arthritis and so-called rheumatoid arthritis. In 31 cases of infectious arthritis of a chronic nature, which they were able to follow up, 24 cases had normal joints, both subjectively and objectively. In some the affected joints had become worse for a few days immediately after operation, but began to improve in two to three weeks. Often it required from six to eight months before all joint symptoms had entirely disappeared. Four cases were classified as improved, because the patients were able to walk without pain. The affected joint, however, had never entirely cleared up, and after operation had at times been worse. Two cases were not improved, and one was worse than before the operation. In the so-called rheumatoid arthritis they were able to follow up nine cases only. Two of these had improved, but this improvement might have been due as much to the general hygienic measures which they followed as to the tonsillectomy. Two cases were not improved, but no new joints were involved. Five of the nine were much worse, new joints having become involved, and they were for the most part helpless.

He concluded from this group of cases that, only in very exceptional circumstances, should any one subject a patient with rheumatoid arthritis to an operation for removal of tonsils, even in cases that give a history of repeated attacks of tonsillitis for many years.

For the past three years patients with chronic arthritis coming to the Stanford University Clinics have been treated on the theory, that every case of chronic arthritis, as of acute arthritis, is due to an infection or to trauma.

The majority of these patients were seen by Doctor Ely in the Orthopædic Clinic. The Clinic Procedure was as follows. A very careful history was taken, and a physical examination was done on each patient. In most cases routine laboratory examination of blood and urine was done. A large number of X-ray examinations and blood Wassermann tests were made.

Special attention was paid to the history of Neisser infection, when treated, how treated, and the length of time treated. Also whether or not the patient had been subject to repeated attacks of sinusitis or tonsillitis. The history of pyorrhœa, root abscesses, and chronic mouth infections was carefully taken up.

In the physical examination, particular attention was paid to the teeth, nasal sinuses, the tonsils, and the genito-urinary tract. When a patient gave

a history of repeated attacks of tonsillitis, and the physical examination showed evidence of chronic tonsillitis, he was not immediately rushed over and subjected to a tonsillectomy, but was carefully examined for other foci of infection. If none was found, then the tonsils were treated as the source of infection.

In many cases a number of foci were found, such as chronic prostatitis and chronic tonsillitis, or chronic prostatitis and root abscesses or pyorrhœa.

After the existence of the focus had been established as well as possible, each case was referred to its respective clinic, that is, the genito-urinary, the dental, or nose and throat, and was treated there. (Treatment to be described later.)

During the treatment and for a considerable length of time afterwards, these patients were followed up and watched by Doctor Ely.

From the card index and catalogue system of the History Room and with the aid of Doctor Ely, the histories of 125 cases of chronic arthritis were obtained. These did not include acute or subacute cases, but only cases in which the arthritis had existed over a period from months to years.

These histories were segregated into treated and untreated cases, and after careful study had been made of the treated cases a special endeavor was made to see personally as many of these patients as possible. In this way a personal interpretation of the results of the treatment can be given.

Of the 125 selected cases only 66 cases were treated, and of the 66 cases 21 were seen personally and the results recorded. Therefore the results of the clinicians in 66 cases and the results of the 21 cases seen by me personally will be given separately. These cases are classified and subdivided according to the mode of treatment and the situation of the focus. The accompanying charts tabulate only the treated cases.

Thirty-three treated cases in which the primary focus was believed to be located in the genito-urinary tract.

Twenty-six cases in which the primary focus was believed to be located in the teeth.

Seven treated cases in which the focus was believed to be located in the tonsils.

Cases in Which the Primary Focus was Believed to be in the Genito-Urinary Tract—The total number of cases in this class were 45. Of this number, 97.5 per cent were men and 2.5 per cent women. The decades in which chronic arthritis was most prevalent in this series are

Years	Cases	Per cent
20-30	22	48.4
30-40	14	30.8
40-50	6	13.2
50-60	2	4.4
60-70	1	2.2
	—	—
	45	100
	650	

DISTANT FOCI OF INFECTION IN CHRONIC ARTHRITIS

Thirty-three cases received treatment in the genito-urinary clinic. This consisted of prostatic massage, and massage of the vesicles, when indicated. This was done usually twice a week. Hot permanganate injections, urethral dilatation, mixed Neisser vaccine and silver nitrate instillations constituted the treatment in general. In four cases vesiculotomy was performed. All these patients were advised to rest as much as possible. In some cases baking, belts, braces and other supports were resorted to.

Of 33 cases which received treatment, 42.3 per cent, according to clinical observation, showed definite improvement. This improvement manifested itself in the loss of pain, the increased amount of motion in the joints, and the ability to get about and to go back to work, 15.75 per cent of the cases showed no signs of improvement. In 40, 95 per cent of the cases, we were unable to secure data.

Eleven cases were seen personally. Of this number ten showed definite improvement. One showed no sign of improvement after a long period of treatment.

The following are a few of the cases in which striking results were obtained.

CASE IX — J. B., cigar clerk, complains of rheumatism for five years. This began in his right shoulder, as a hot stinging sensation. Two months later his left shoulder and right knee became involved.

Family History — Neisser infection in 1909, also a chancre shortly after this. Salvarsan three times. Catarrh of the nose all his life. Teeth and tonsils have never given him any trouble.

Physical Examination — Heart and lungs are negative. All the joints are swollen, especially the knees. The patient walks on crutches. Motion in all joints is limited. He has pyorrhoëa and very poor teeth. His prostate and seminal vesicles are enlarged and tender. Prostatic secretion contains many pus cells. Discharge from the meatus. No Neisser organisms were found. X-ray shows a chronic arthritis of both knees, with some new bone formation. Wassermann was negative.

Diagnosis — Arthritis, chronic multiple, prostatitis, chronic, vesiculitis, chronic, urethritis, chronic, pyorrhœa alveolaris.

This patient was treated for a period of five months. The treatment consisted of hot permanganate injections, prostatic massage and finally the vesicles were drained.

Ten weeks after treatment was started this patient was seen walking along the street with a cane. All his joints were less swollen, and he was greatly improved. This patient was watched for over six months, and was seen to improve steadily. At the end of two years he was again seen. At this time all his symptoms had disappeared and he was practically well. Two and one-half years after treatment was begun, the patient was again seen, and he was perfectly well, and had never had any recurrence of his symptoms.

CASE X — Mr. C., time clerk, complains of soreness and swell-

ing of the right wrist and fingers of the right hand Feet are tender and flat He also has a slight sore throat

Past History—Rheumatism in both ankles in 1884 Typhoid in the same year Neisser infection four times Three of these were cured in a few weeks, but the last one lasted over a month At times the patient had rheumatism so badly that he was unable to raise his hand to his mouth to feed himself

Physical Examination—Heart and lungs are negative Both feet are flat Left ankle is swollen and immobile Right wrist is painful on motion Motion is restricted in all directions in this joint The left wrist and the metacarpophalangeal joints are painful He has a few bad teeth Prostate is large and the secretion contains pus He has chronic urethritis and tonsillitis X-ray shows an unerupted third right upper molar Wassermann negative Hæmoglobin, 89 per cent Albumen in the urine in a light cloud

Diagnosis—Arthritis, chronic multiple, urethritis, chronic, prostatitis, chronic, vesiculitis, chronic, tonsillitis, chronic

The patient was put through a vigorous course of treatment in the genito-urinary clinic This consisted of massage, hot permanganate injections, sounds and urotropin At the end of one month his hands were practically well His feet were much better, but he still had some pain in them At present he is able to walk comfortably and to work, which he was not able to do previous to treatment Two months after treatment he was practically well

In these cases in which the focus is situated in the genito-urinary tract, in order to obtain definite improvement it is essential that the patient undergo a long-continued treatment Complete eradication of the focus is necessary The results in these cases where the treatment has been thorough are permanent, as shown in Case IX In this case the patient has been well for over two and one-half years

Cases in which the primary focus was believed to be located in the teeth

In the last one and one-half years the clinicians at Stanford have laid greater stress upon the teeth as locations for foci of infection This is evidenced by the fact that 49.6 per cent of the cases in this series are placed under this division

Of 62 cases of chronic arthritis believed to be due to the foci of infection in the jaws, 72.5 per cent were men and 27.5 per cent women Thirty-two per cent of the cases occurred between the ages of forty and fifty years

Years	Cases	Per cent
20-30	4	6.44
30-40	16	25.76
40-50	20	32.20
50-60	14	22.54
60-70	8	12.88
—	—	—
	62	100
	652	

DISTANT FOCI OF INFECTION IN CHRONIC ARTHRITIS

It is of interest and an important fact to note that over 54 per cent of the cases occur between the ages of forty to sixty years. This about the stage of life when decayed teeth and root abscesses are most prevalent.

Twenty-six cases were treated, and this treatment consisted in scraping the teeth, removing the salivary calculi, filling in many cases, opening and draining root abscesses, extraction of roots and treatment of pyorrhœa.

CASE V—Mrs V, aged sixty years, Hungarian housewife, complains of pain in the right knee. This is increased on motion. Duration, four years. Some swelling the last four months.

Past History—No trauma. Gall-stone operation in 1912. Polyp removed from the nose at about the same time. Rheumatism in 1901. Pyorrhœa for a long time.

Physical Examination—Some swelling at the head of the tibia. No redness or tenderness. No restriction of motion. Some grating. Marked pyorrhœa. X-ray shows some new bone growth about the head of the tibia and the lumbar vertebræ. Also an unerupted molar.

Diagnosis—Arthritis, chronic of spine and knees, oral sepsis, pyorrhœa alveolaris.

Treatment—Teeth extracted. Pus drained. Pyorrhœa treated. Baking and massage. This patient received five treatments in three weeks. She was watched carefully over a period of eight months. Almost immediately after treatment was instituted the pain and swelling became less. Motion was no longer restricted, and she was practically well.

CASE XXIV—Mr F, motorman, aged fifty-four years, complains of stiffness in the knees for the last year. Pain when walking and when standing. At times a feeling of hot irons in the feet.

Past History—General condition always excellent. No trauma. Neisser infection denied. No history of tonsillitis or infectious diseases.

Physical Examination—Thickening and swelling of the right knee. Patella grates. Teeth poor. Bad pyorrhœa. Perforation of right drum. Otitis media. Blood bad, urine negative.

Diagnosis—Arthritis, chronic of knee, pyorrhœa alveolaris, otitis media, chronic.

Treatment—Lower cuspids extracted. Teeth scaled. Second molar extracted. Bier treatment. Treated three times.

Five days after the first treatment the patient was very much better. The swelling had decreased, and he was able to bear weight on the knee. The burning sensation in the feet had disappeared. Three months after treatment, the patient still continued to improve.

CASE XII—Mr S, Austrian iron worker, aged forty-nine years, complains of pain in the spine and lumbar muscles. This first followed an attack of constipation three years ago, and at the time lasted one week. Two weeks ago he had a similar attack of pain.

Past History—Usually well. Four years ago was struck by an

automobile, and his head was slightly injured Melancholia at times, otherwise the history is negative

Physical Examination—Heart and lungs are negative Lumbar spine is stiff Flexion is lost There is a kyphosis at the eighth thoracic vertebra Many bad teeth, and some pyorrhœa X-ray shows considerable spurring of the thoracic spines Hæmoglobin, 70 per cent Albumen in the urine in a slight amount

Diagnosis—Arthritis, chronic, of the spine, oral sepsis and pyorrhœa

Treatment—Three lower molars were extracted A large granuloma one-quarter of an inch in diameter was removed Pyorrhœa treated Teeth scaled Spine strapped, and a belt fitted Treated twice Five days after treatment the patient was very much improved Pain was much less severe Four days after the second treatment the patient walked about one and one-half miles to the clinic He stated, that before treatment he could never have done it on account of pain

This class of patients differs considerably from those in the former division In those, long-continued treatment was necessary to obtain improvement, while in these definite improvement is noticed in one treatment, and in a very few days after treatment This is also in accordance with the findings in the clinic

In this series 61.5 per cent of the cases treated showed definite improvement This evidenced itself by the disappearance of pain and swelling, and the regaining of lost function

In 15.3 per cent of the cases no signs of improvement were shown, and one seemed to be worse after treatment

In 23.3 per cent of the cases we were unable to obtain data

Eight cases were seen personally Four of these showed definite improvement

Cases in which the primary focus was believed to be located in the tonsils

In this division there were 18 cases All had a history of repeated attacks of tonsillitis In this class 55 per cent of the cases were women and 45 per cent men The age of incidence in this series is given below

Years	Cases	Per cent
10-20	3	16.66
20-30	2	11.11
30-40	3	16.66
40-50	3	16.66
50-60	5	27.77
60-70	1	5.5
70-80	1	5.5
	—	—
	18	100

In only seven of these cases was treatment given, and this in all cases consisted of tonsillectomy Of the seven cases, according to clinical observation, 4 showed marked improvement

DISTANT FOCI OF INFECTION IN CHRONIC ARTHRITIS

CASE II—Mrs J, Swedish housewife, May 29, 1915, complains of pain in the bones and joints, for the past seven months. Fingers, wrist, back and shoulders are painful and stiff.

Past History—Has had measles, mumps and whooping cough. Five years ago she had a tonsillar abscess. Has had swelling of the feet and ankles since 1914.

Physical Examination—Heart and lungs are normal. The hands, left elbow, left shoulder and right foot are swollen and tender. Tonsils are hypertrophied and covered with a thin exudate. Nose is negative. X-ray shows demineralization of the bones of the right elbow and shoulder. Marked synovial thickening at the wrist.

Laboratory Reports—Blood, hæmoglobin, 65 per cent. Urine, a light cloud of albumen.

Diagnosis—Arthritis, chronic multiple, tonsillitis, chronic.

Treatment—Patient was in bed almost one year. Sodium salicylate in large amounts was administered. Elimination by sweats and baking. June, 1915, the tonsils were removed. Three weeks after operation the patient showed marked improvement. Pain was less severe and the swelling in the joints had decreased. She is now walking, whereas before she was bedridden. Four months later she was still improving, the joints were much better, and the swelling had practically all subsided. She is now able to do some housework.

For eighteen months this patient was watched, and she showed marked improvement during this time. At the end of two years she was again seen. At this time she was not quite so well as she had been previously. She was up and around and able to do housework, but at times she had some pain in her joints.

CASE XX—Mr K, Russian painter, complains of pain in his feet and knees. This began insidiously about three weeks ago. For a long time previous to this the patient had pain in his left heel and ankle.

Past History—Always healthy. Denies Neisser infection and lues. No sore throat or tonsillitis. He is constipated, and suffers from hemorrhoids.

Physical Examination—The patient walks very stiffly. The left foot is abducted. The metatarsal joints of his left foot are painful on motion. He has several bad teeth. The tonsils are enlarged.

Diagnosis—Arthritis, chronic, of knees and feet, tonsillitis, chronic.

Treatment—Tonsillectomy. One week after treatment the patient stated that he had not suffered any pain since the operation. Motion is no longer painful.

Two cases of this series were combined with genito-urinary infections, and it was impossible to determine from what treatment they derived their benefit.

Two cases were no better after tonsillectomy.

Two cases were seen personally, and in these the results were very striking.

SUMMARY

Clinical Observations

Kind of cases	No of cases	Improved cases	Not improved cases	Not seen cases	Total cases
Genito urinary	33	14 42 3%	5 15 15%	14 42 3%	33 100%
Teeth	26	16 61 5%	4 15 1%	6 23 2%	26 100%
Tonsils	7	3 42%	2 28 4%	2 28 4%	7 100%
Total	66	33 50%	11 16 66%	22 33 33%	66 100%

Author's Observations

Kind of cases	No of cases	Improved cases	Not improved cases	Not seen cases	Total cases
Genito-urinary	11	10 30 3%	1 3 33%	22 66 66%	33 100%
Teeth	8	4 15 4%	4 15 4%	18 69 2%	28 100%
Tonsils	2	2 28 48%	0	5 78 60%	7 100%
Total	21	16 24 2%	5 7 6%	45 68 20%	66 100%

CONCLUSIONS

1 Fifty per cent of the cases of chronic arthritis treated at the Stanford University Clinics by the removal of foci of infection, according to clinical observation, showed definite improvement

2 From personal observation of 21 cases, the following was concluded (a) 76 2 per cent. of the cases showed definite improvement, (b) 19 0 per cent showed no improvement or change, (c) 4 8 per cent were worse after treatment

3 Although the percentage of improvement did not vary greatly in the different groups, the most striking results were obtained in those cases in which the focus was situated in the genito-urinary tract

4 Long-continued faithful treatment is necessary before improvement can be expected in the cases in which the focus is located in the genito-urinary tract

5 Very rapid recovery with very few treatments was obtained in those cases in which the teeth were the seat of infection

6 Removal of the tonsils in several cases was followed in a few days by loss of pain, and later by return of function to the injured joint

7 The compilation of these statistics was made possible through the kind assistance of Drs Ely, Hewlett, and Williams, also through the aid of the staff of the history room

DISTANT FOCI OF INFECTION IN CHRONIC ARTHRITIS

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INJURIES OF THE SEMILUNAR CARTILAGES OF THE KNEE-JOINT

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THE semilunar cartilages are fibro-cartilaginous structures placed within the knee-joint to deepen the cavity for the reception of the condyles of the femur. They are wedge-shaped with their apices to the center and their bases to the periphery of the joint. Their presence allows a more even distribution of the wear and tear on the joint surfaces than would otherwise be the case. The external cartilage is less intimately associated with the capsule of the joint, and being more free it can readily slip from the grasp of the external condyle and the external tuberosity of the tibia. It is thicker, broader, and more nearly circular than the internal cartilage, and on this account we find the area of contact between the external condyle of the femur and the external tuberosity of the tibia less extensive than the contact on the inner side of the joint. The internal cartilage, at its periphery, is closely adherent to the capsule and internal lateral ligament and thus is not permitted the laxity and consequent ability to glide out of harm's way that the external cartilage enjoys. It is not so thick as the external cartilage and is more crescent shaped than circular. The internal condyle of the femur crowds it more than does the external condyle the outer cartilage.

In the past we have been prone to speak of a loose semilunar cartilage as being the cause of a mechanical derangement of the joint. While it is possible that some derangements are caused by an internal semilunar cartilage that is abnormally mobile, there is no doubt that the vast majority of so-called derangements are in reality due to fractured or torn semilunar cartilages. This has been drawn to our attention repeatedly by Sir Rutherford Morison.

The history of a typical mechanical derangement of the knee due to an injury of the semilunar cartilage is clear cut as a rule. The patient is usually a male under 35, in the active period of life. The attack may have come on during some game or trial of strength. The exact manner of infliction of the injury may be a little clouded, but almost invariably the story is elicited that the knee was in moderate flexion and the foot or leg in external rotation. In this position the internal semilunar cartilage is placed the deepest in the joint. When extension is attempted, the internal condyle of the femur catches the cartilage and one of three things must take place to avert disaster, the force must be stopped, the cartilage must slip out of the grasp, or the cartilage must be firm enough

INJURIES OF THE KNEE-JOINT SEMILUNAR CARTILAGES

to stand the pinching, crunching force inflicted on it. It is usually impossible to stop any such violent contraction of a muscle so powerful as the quadriceps in time to prevent injury, once the contraction is well established. The fibrocartilaginous structure will not readily withstand the extreme force to which it is subjected, and the cartilage usually rips or tears in its longitudinal axis, the condyle of the femur forces the detached portion to the mesial portion of the joint, and thus prevents extension, the knee being locked in partial flexion.

The subjective symptoms are severe pain and immediate disability, the patient is unable to use the knee, and often falls to the ground, grasping his knee with both hands. The pain is not due to the tear in the cartilage, since the semilunar cartilages are not supplied with nerves, but to the stretch on the ligaments. It may be necessary to aid the patient or even carry him to his bed, and, if reduction is not immediately made, the period of enforced quiet and disability will be prolonged and will depend entirely on the character of the tear or fracture present in the meniscus.

A distinct crack may be heard at the time of injury. Swelling and effusion follow and subside only after days. The cartilage may gradually, of its own accord, as it were, glide back into place, extension of the knee then becomes possible. Most of the pain is referred to the inner side of the knee just anterior to the internal lateral ligament at the joint-line. The patient may even feel a protuberance or swelling there, and in chronic cases with repeated locking, it may be quite noticeable, as the synovial effusion may not be so great in these cases of long standing as in early cases. The lump only appears at the time of locking and is always noted at the same spot. Patients often say the knee is dislocated. This statement given by an intelligent patient usually means one of three things, either a torn semilunar cartilage, a dislocated patella, or a loose osteo-cartilaginous body. If the semilunar cartilage is torn it is best, as hereafter described, that the cartilage shall be immediately reduced. Whether or not there is to be recurring locking depends largely on whether reduction is promptly done, whether the part is kept at rest long enough to permit of healing, and on the type of the tear in the meniscus.

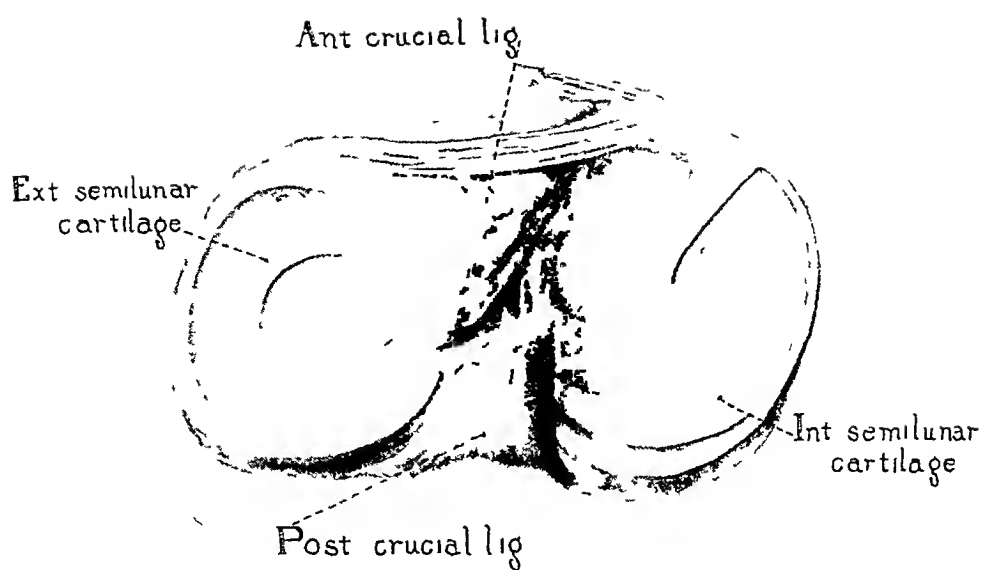
By far the most common tear seen is the so-called "bucket-handle" tear of Morison (Fig 1). It consists of a displacement inward of the torn middle three-fifths of the meniscus so that it lies mesially to the internal condyle. It is attached to the anterior one-fifth and the posterior one-fifth so that it effectually blocks complete extension. It is astonishing that this condition may exist in the chronic recurring cases and the patient still be fairly active and getting about very well after some months, the only symptoms being incomplete extension and occasional locking. There are other types of tears but in my experience this is the most common. The swelling and pain are often marked in the early locking, but as the attacks become more frequent, a certain

tolerance seems to be established, all symptoms being less marked. The patients complain of a feeling of insecurity and dread, however, that in itself greatly reduces their efficiency and may even keep the more timid from working.

If the recurrent trouble in the joint is due solely to injury to a semilunar cartilage there is no periarticular thickening, and if this thickening is present with a somewhat indefinite history the surgeon should be very slow to make a diagnosis of derangement due to a damaged semilunar cartilage. Periarticular thickening always means that arthritis is present. In fact, the presence of any residual symptoms or signs between attacks should make the surgeon very careful about making a positive diagnosis of an injured semilunar cartilage. The original trauma is often so sudden and the patient so disturbed that an incomplete history is given and it is only by careful extraction of the facts that a clear statement can be obtained. In a few instances I have been unable to get a history of anything that might be called a severe injury. The locking may have come on when the patient was walking, and, in one instance, locking occurred when the patient merely turned over in bed.

While the clear-cut case, as outlined, is easy of diagnosis there are other affections of the knee-joint which are more or less often confused with this condition that must be considered in the differential diagnosis. It would seem that tuberculosis of the knee would not present symptoms of this nature, but tuberculosis of the synovial type with its mild symptoms extending over a length of time is often confusing. There may be twinges or attacks of pain simulating locking of the joint which are caused by the fringes of thickened synovia being nipped between the joint surfaces, but the chronicity of the complaint with the periarticular thickening, persistent effusion, and the absence of severe locking are enough to put the surgeon on his guard. Also careful general examination will perhaps disclose another tuberculous focus in the body such as a pulmonary or genito-urinary lesion, which in itself, although not sufficient to corroborate a diagnosis of a tuberculous knee-joint, strengthens such a diagnosis. Some of the infectious arthritides may also be difficult of differentiation, but the catchings complained of are mild and periarticular thickening is also present.

The chief condition to be differentiated and the one producing nearly the same symptoms as a tear in the semilunar cartilages is the loose body caused by osteochondritis dissecans¹ (Fig 2), hypertrophic arthritis (Fig 3), or osteochondromatosis (Fig 4). Clinically, the loose body may be felt, but unlike the semilunar cartilage it varies in its position and may be felt above the patella or to the outer or inner side of the joint. The locking may be quite as painful, but it is usually of shorter duration, and the swelling is rarely so great. In osteochondromatosis the bodies are generally quite numerous, and are easily to be felt at all times. The roentgenograph is the final court and will invariably show any osteo-



MWhiting

[FIG 1 —Internal semilunar cartilage displaced to the mesial portion of the joint, anterior portion blocking extension, called bucket handle type by Rutherford Morison



FIG 2—Osteochondritis desiccans Loose osteocartilaginous body lying at the site of origin



FIG 3 —Osteocartilaginous loose bodies due to hypertrophic arthritis

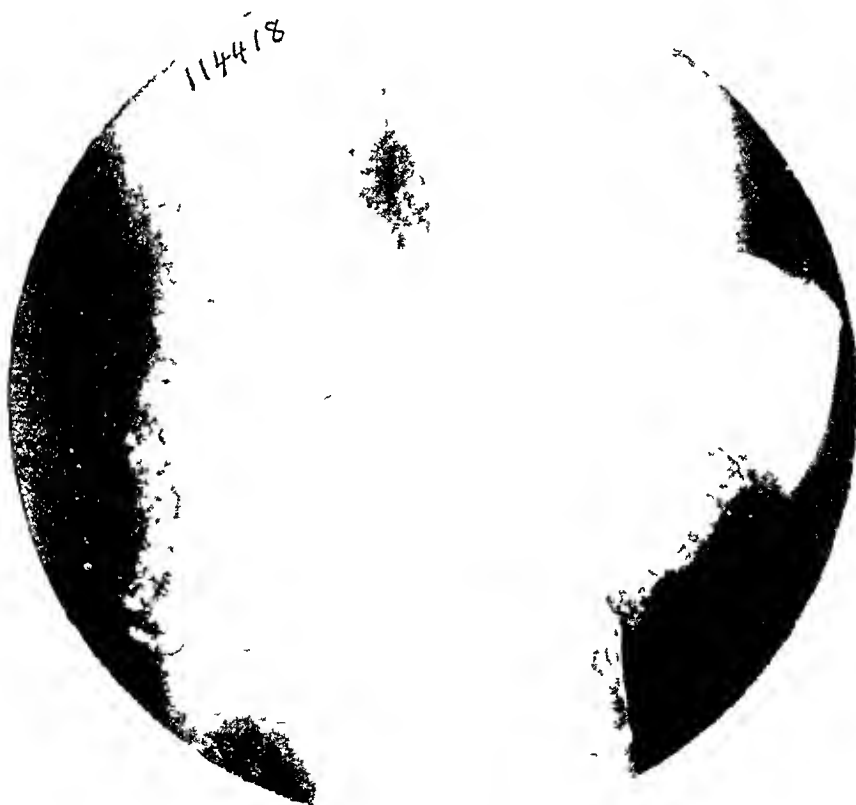


FIG 4 —Osteocartilaginous loose bodies due to osteochondromatosis

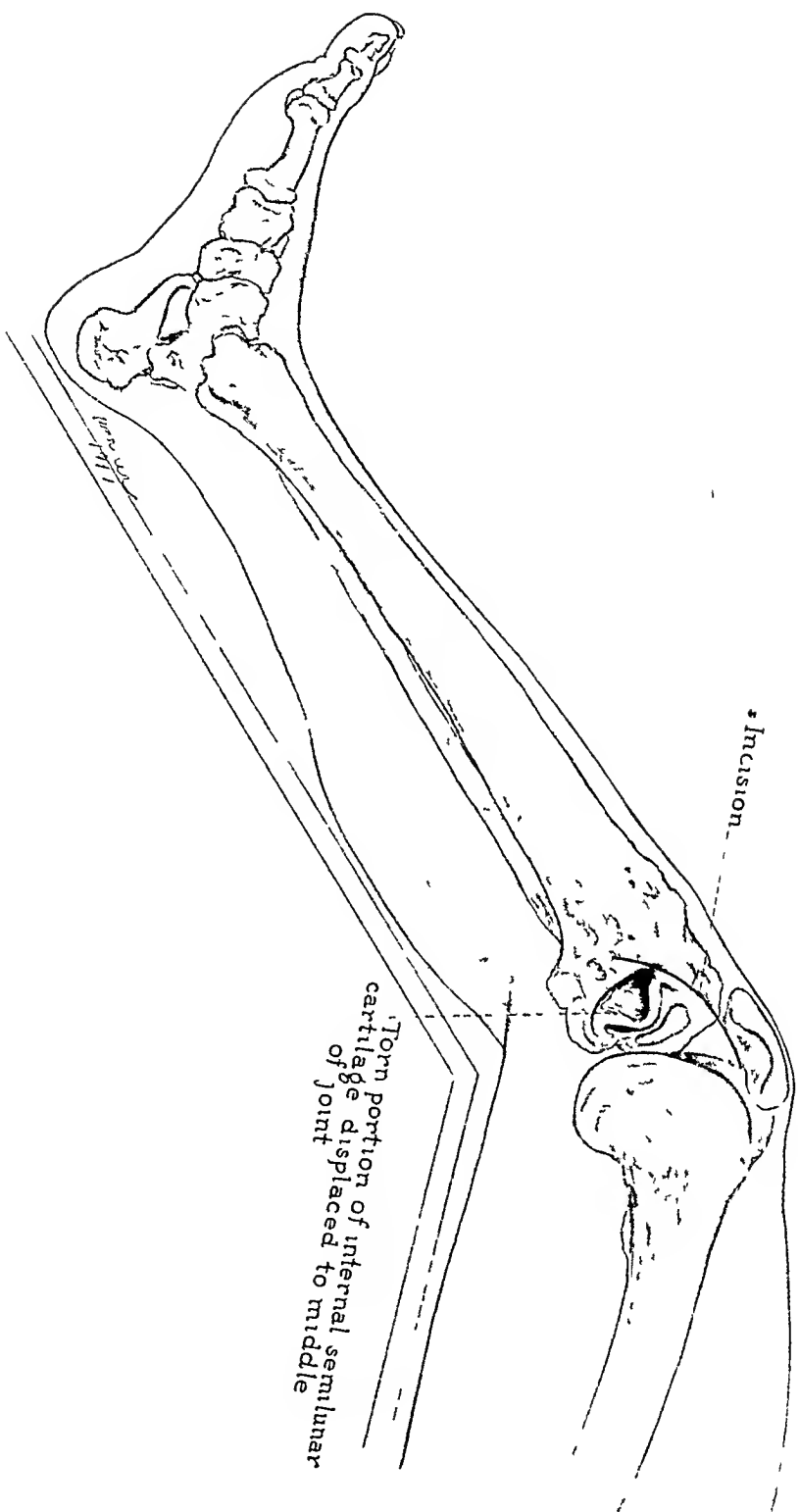


Fig 5—Incision used with leg flexed at an angle of 140 degrees

cartilaginous body If in a patient having typical locking of the knee-joint a good series of rontgenograms show nothing, it may be concluded that the locking is due to a damaged semilunar cartilage and that the chances are about fifty to one that the offending meniscus is the internal

In my discussion so far I have mentioned only the symptoms produced by the internal semilunar cartilage The same general symptoms are present if the derangement is due to the external cartilage, but the manner in which the injury is received is not necessarily the same I know of no typical position in which such damage takes place as is so well known regarding the injuries to the internal semilunar cartilages The pain, however, is usually referred to the outer side of the joint and a restoration of even casual function is not apt to take place until the offending cartilage is removed

If the surgeon is called when the first locking occurs he should, if possible, immediately reduce the torn or fractured cartilage It is not generally necessary to give an anæsthetic as the patients are usually young, hardy, and vigorous and can well stand the pain incident to the reduction It is best to place the patient on the floor, flex the knee to the limit, the thigh to well beyond a right angle and suddenly when the patient is off guard, with the thumb pressing over the anterior attachment of the cartilage, extend the knee If the reduction is complete the patient will usually tell you that it feels better If this assurance is lacking it should not be disregarded, the patient is usually right If the reduction is complete, as indicated by complete extension of the joint, and the statement of the patient, the leg should then be put in a cast for at least four weeks This may insure such healing that a recurrence will not develop If reduction is impossible the joint should be opened and the cartilage removed The difficulty is that it is not always possible to determine whether or not reduction is complete, and sometimes it is only after the period of fixation is over and the patient is permitted normal motion that the surgeon can say whether operative interference will be necessary When there is no question that conservative measures will not accomplish reduction, the joint should be opened In the other more doubtful cases operation should never be resorted to until after at least two clear-cut derangements or lockings have taken place Both Sir Robert Jones and Sir Arbuthnot Lane make the statement that recurring locking may be an etiologic factor in the development of tuberculosis in such a knee While their theory that chronic irritation is a possible factor in the development of tuberculosis is not usual, we must give heed to a statement by such eminent surgeons 'The recent war has shown more positively than was possible to demonstrate in civil practice that the knee-joint has a very definite resistance to infection If the knee-joint is accorded the aseptic respect shown the abdomen, no fear need be entertained regarding exploration of the joint For a number of years I have not given the knee-joint any more preparation than

has been given the abdominal cases in the Mayo Clinic. When necessary the knee should be shaved the day before operation, but I do not hesitate to shave the leg on the operating table if it has been neglected previously. The ordinary benzine and iodine preparation is used, care always being taken to clean the knee both in the flexed and extended positions. The part is draped with sheets and towels in the usual manner, and a rubber tourniquet applied. This technic has been employed in considerably more than 100 cases and we see no need for any more extensive preparation.

The operative technic outlined by Sir Robert Jones has been more or less followed. After the patient is asleep he is placed in slight Trendelenburg position and the foot of the table is dropped so that the knee is in about 140° flexion. The triangular space bounded by the patella and patellar ligament, the head of the tibia, and the inner condyle of the femur, is readily outlined and may be opened by a curved or straight incision (Fig 5). If there is no fracture or tear in the cartilage, the surgeon should be loath to remove the meniscus. A pathologic condition should be evident before any structures are removed. If exposure of the meniscus is difficult, the incision in the capsule may be enlarged, care being taken not to injure the internal lateral ligament, also if the foot is rotated outward and the leg everted with the knee still in the semiflexed position, a better view may be obtained. It is generally sufficient to remove a little more than the anterior three-fifths of the cartilage. It is well to leave a small rim attached to the capsule and thus no injury will be done to the ligament. The capsule should be closed in layers, plain catgut being used. The skin may be closed with non-absorbable sutures. A well-padded dressing is firmly applied before the tourniquet is removed. A plaster of Paris cast from the groin to the ankle is applied over all with the knee in extension and insures no damage from movements while the patient is coming out from the influence of the anæsthetic. On the eighth day the cast may be removed and the superficial stitches taken out. On the tenth day the deep stitches are removed, function is permitted as soon as the patient desires it.

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REPORT ON THE USE OF HYCLORITE AND A MODIFIED DAKIN'S SOLUTION AS A SUBSTITUTE FOR THE ORIGINAL DAKIN'S SOLUTION

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IN an active surgical hospital there is always a demand for efficient antiseptics. Of recent years, the hypochlorite solutions have come into prominence, and enjoy a wide reputation, and quite a range of applicability. Dakin's solution is the hypochlorite solution most extensively used, and is the solution which was used in this hospital for a number of months—until a modification was adopted, the preparation of which will be described later.

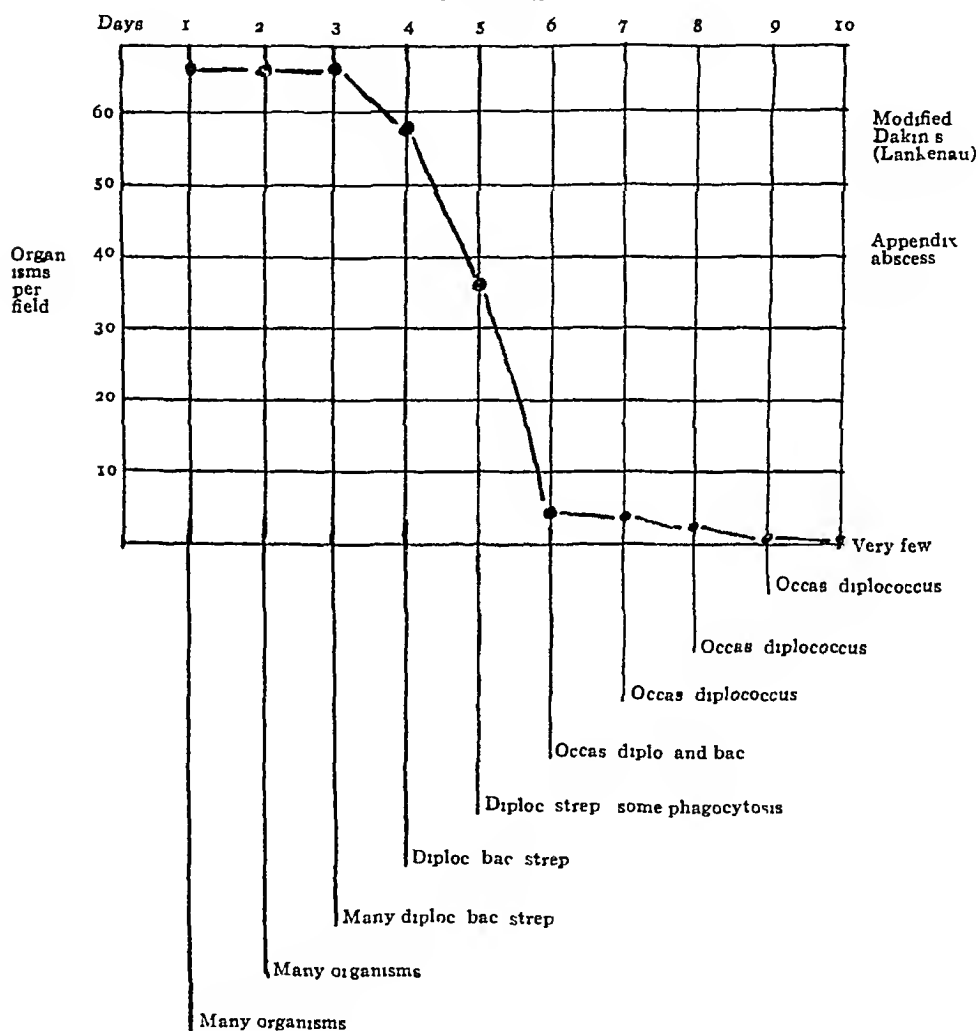
In November, 1919, our attention was drawn to "Hyclorite," a concentrated sodium hypochlorite solution which had recently been accepted as a new and non-official remedy by the Council of Pharmacy and Chemistry of the American Medical Association. Since this solution seemed easy to dilute, was of a standardized hypochlorite strength, and was said to be very stable, its use was begun in the surgical wards. The hypochlorite solution supplied by the hospital pharmacy was used in the controls, and both subject and control insofar as possible were identical types of cases. For the most part, draining appendix abscesses and other infected abdominal wounds were used. Although the shortcomings of wound-smears and bacterial counts as a gauge of wound-healing were recognized, yet it seemed to be the simplest means of tracing our results. Consequently, at each dressing smears were made of the wounds under treatment, and examined. At the same time, close touch with the clinical aspects of the cases was kept. Several typical charts are appended which are self-explanatory, and indicate the factors which were considered in each of the series studied.

After using Hyclorite for several weeks, inquiry into the method of preparation of the Dakin's solution used in our controls, and in general use throughout the institution, revealed the fact that the two solutions are remarkably similar. The demand for hypochlorite solution in large quantities led the pharmacist to digress somewhat from the standard method of preparation, substituting NaCl for NaHCO_3 —using the NaCl in such quantity as to produce an 0.85 per cent strength in the finished product. It was thought that by this means the free carbonates could be eliminated, and the solution thus rendered more stable. The fact that a sample of this solution, recently titrated after a year and three months standing in a corked brown bottle, showed infinitesimal loss of available chlorine, justified the hopes of a more stable preparation. As no adverse criticism of this solution was forthcoming, a "stock solution" was made.

in order that there might be an economy in time and labor, as well as bulk Thereupon a solution was made containing five times all the components except water, and the dilutions made 1 4 with water as required Since there are nearly 30 quarts of this modified Dakin's solution used daily, it will be seen that some such method is justifiable

Method of Preparation and Titration, Results—The method of testing the two solutions, *i e*, Hyclorite and modified Dakin's, is identical In

CHART I



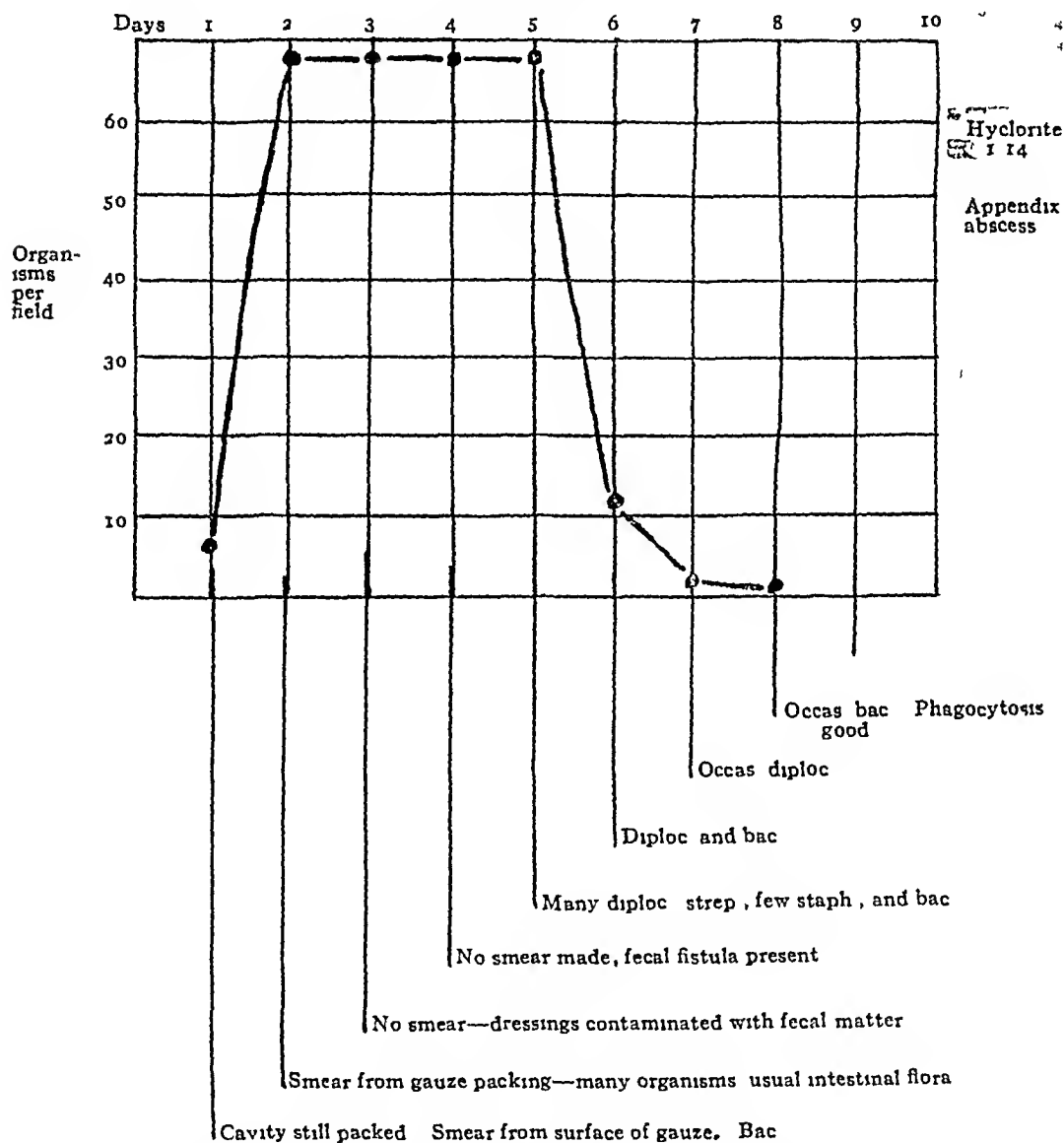
preparing and testing our own solution, the original technic of Daufresne is followed, except as noted above—the substitution of NaCl for NaHCO_3 . We have frequently titrated fresh and twelve-hour-old solution of Hyclorite and our own modified Dakin's, and find that the two solutions in proportionate dilutions titrate practically the same, the Hyclorite showing slightly more available chlorine than the modification. Neither solution shows any appreciable loss of strength after standing over night in an open graduate, each shows a very small calcium content,

THE HYCLORITE ANTISEPTIC

and the same alkalinity. In this connection too much stress cannot be laid on the testing of the chlorinated lime used in the preparation of the solution. Assay of this ingredient as it comes to the hospital shows a variance from 9 to 40 per cent chlorine. The chlorinated lime of the U.S.P. should assay 30 per cent chlorine, and any excess or deficiency must be corrected as shown in the "Table of Ingredients."

Methods of Using—"Hyclorite is used in dilution of 1:7 when an

CHART II

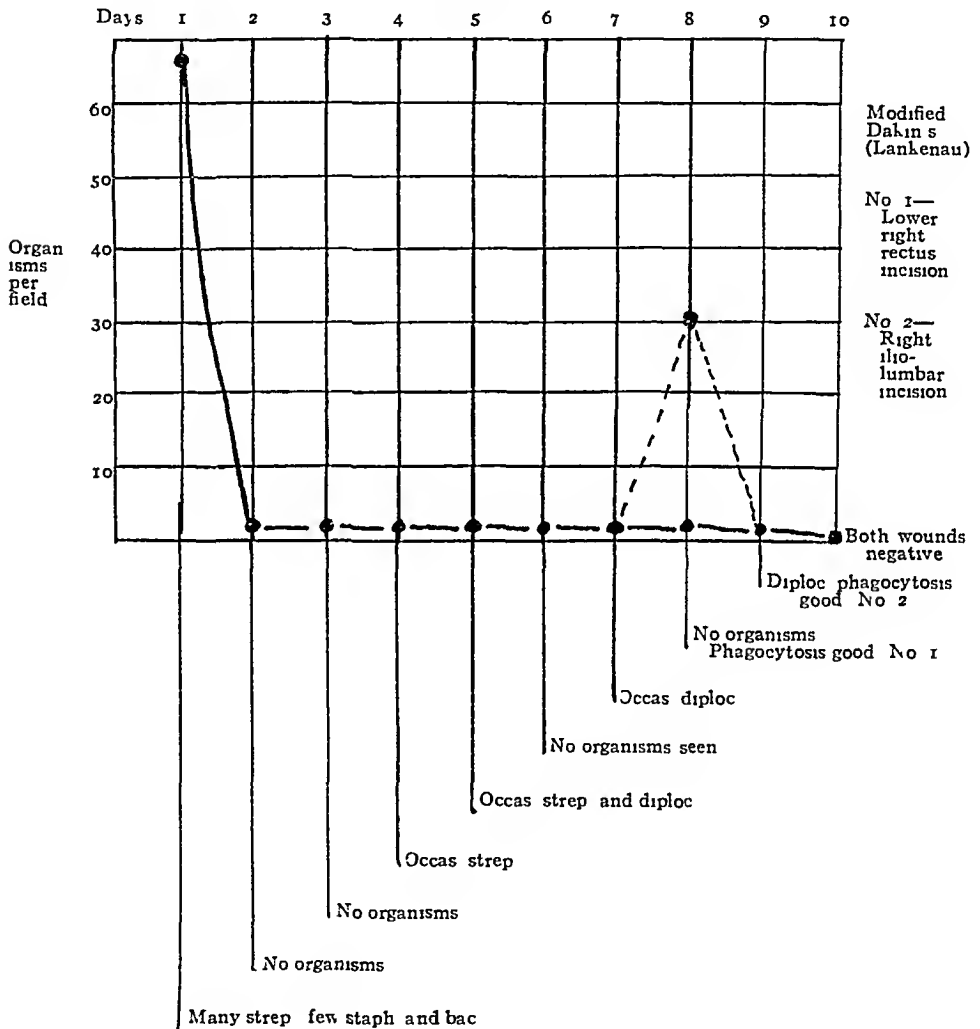


irrigation is needed which corresponds to Carrel-Dakin solution. The dilution is made in the dressing-room immediately before using. The modified Dakin's is dispensed already diluted, *e.g.*, 1:4 of the "Stock Solution" with water.

Stock solution is now dispensed to all the surgical wards in corked brown bottles. Thus Hyclorite and our modified Dakin's can be used full strength, or in any dilution required, by mixing immediately before using. When either solution is used full strength, it is applied on a

cotton swab In dilutions of 1 3, 1 7, 1 14, 1 20, 1 500, and 1 1000, the ordinary gravity irrigating apparatus may be used, or the original technic of Carrel However, we have found it to be quite as effective to loosely pack the wound with gauze laid around Dakin's tubes and allow the ends to protrude from the dressing In this way, the gauze may be kept moist by injecting the solution in desired strength, by inserting the nozzle of a glass syringe into the ends of the tubes

CHART III



SUMMARY OF RESULTS

For the purpose of example and of explanation, three charts are shown, representing respectively three series of cases Series 1, simple recovery, Series 2, complicated recovery, Series 3, complicated recovery with secondary operation

Clinically, we have found that in irrigating infected abdominal wounds with a dilution of 1 7 Hyclorite, or 1 4 of our modified Dakin's

there is apt to be considerable irritation, and dilutions of 1:4 and 1:8 respectively, are more to be preferred, especially if no slough or dense layer of pyogenic membrane is present to protect the nerve endings. Full strength of either solution applied to devitalized or sloughing tissue is remarkably efficient, and it is superior to silver nitrate and other caustics, in our opinion. Used for this purpose it should be applied with a cotton swab, and the healthy tissue protected with gauze. We have used a dilution of Hyclorite 1:3 in an empyema cavity which was discharging freely one month after thoracotomy. In this case such a strength was justifiable, since its antiseptic properties and perhaps its caustic or proteolytic properties could act without much danger of breaking down nature's barrier membrane. In this case, furthermore, the solution was made weaker as soon as the bacterial count began to come down. In another empyema, 1:500 Hyclorite irrigations were begun immediately after operation, and in four days the solution returned clear. The patient was discharged from the hospital and returns to the dispensary for treatment. Progressive improvement is reported.

As soon as the infection is cleared up clinically, and no organisms are reported from the smear examinations, the irrigations should be stopped, for in several instances, where we have thought to stimulate granulation in such wounds, a small, non-granulating or senile wound has resulted. We have diluted our solutions as soon as the infection is controlled—thus in the case of Hyclorite, from 1:3 to 1:14, and finally 1:500. We have observed a rise of temperature in two instances (Mrs. D and Mrs. B), where Hyclorite was used as an irrigation of abdominal wounds. There was no other apparent cause for the phenomenon in either case, and as the irrigation was done very soon after operation, we assume that the pyogenic membrane had been broken down in places, allowing the entrance of organisms and toxins into the lymphatics. At any rate, discontinuance of the irrigations resulted in immediate fall of temperature.

CONCLUSIONS

1 Hyclorite is indicated wherever Dakin's is indicated (in dilutions of 1:7).

2 It is of value when applied full strength and 1:3 in chronically infected wounds, and to dissolve slough.

3 It should be a valuable antiseptic for use in office work or in treating a few patients, because of its stability, and its ease of dilution to various strengths.

4 For large institutions requiring large quantities of a hypochlorite solution, the modification of Carrel-Dakin solution as prepared at this hospital answers every purpose, being more staple than that prepared by the Daufresne technic, and far more economical than Hyclorite.

5 The "Stock Solution" (as prepared at this institution) fills every requirement in which full strength Hyclorite might be used, being only slightly weaker in available chlorine.

A GASTRO-ENTEROSTOMY CLAMP SIMPLIFIED AND IMPROVED

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SEVERAL years ago while assisting a well-known surgeon in performing a gastro-enterostomy certain extraordinary conditions presented themselves rendering the operation extremely difficult. The laparotomy was performed through an unusually thick abdominal wall and after revealing a duodenal ulcer, the application of the usual Roosevelt clamp to the stomach and the jejunum was attempted, but a tremendously thickened transverse mesocolon rendered the procedure practically impossible, and after several futile attempts it was given up. Almost nonplussed by this combination of conditions, the operator, whose experience in stomach surgery is as great as that of any man living, was finally compelled to perform the operation without clamps in a welter of blood and intestinal contents.

Although our patient made an excellent recovery, the extreme difficulty of the operation made an indelible impression on my mind, and some years later, when I had acquired an operating room of my own, a somewhat similar case occurring with all its attending problems of technic, vividly recalled the earlier experience. I then resolved to devise some type of a clamp which I believed would be more satisfactory than those in general use and I take this occasion to present an instrument which I have been using for some time with great satisfaction.

Gastro-enterostomy was first performed successfully by Wolfier at the suggestion of Nicoladini in 1881. It was an operation in which little confidence was placed, for stomach patients were usually treated medically until moribund, and surgical treatment was utilized only as a last resort. The mortality was high in the operations performed prior to 1885, averaging over 65 per cent. Every sort of mechanical device imaginable was used in the earlier operations, but it was not until the posterior operation of Von Hacker was described that the gastro-enterostomy clamp, such as we understand it to-day, came into general use. For many years the operation was performed with a pair of separate clamps, these finally being supplanted in the hands of many operators by the combined clamp of the Roosevelt or Linnartz type. Even to-day there is no uniformity about the technic of the operation and no one type of instrument has universal popularity. One surgeon will proceed with a pair of Lane gastro-enterostomy forceps or a pair of Kocher resection forceps. The next will prefer the Linnartz or perhaps the combination of two Mayo-Robson forceps. The Thomas intestinal clamp is used by some, the Moynihan clamp by others, while still other thoroughly capa-



FIG 1.—Gastro enterostomy clamp

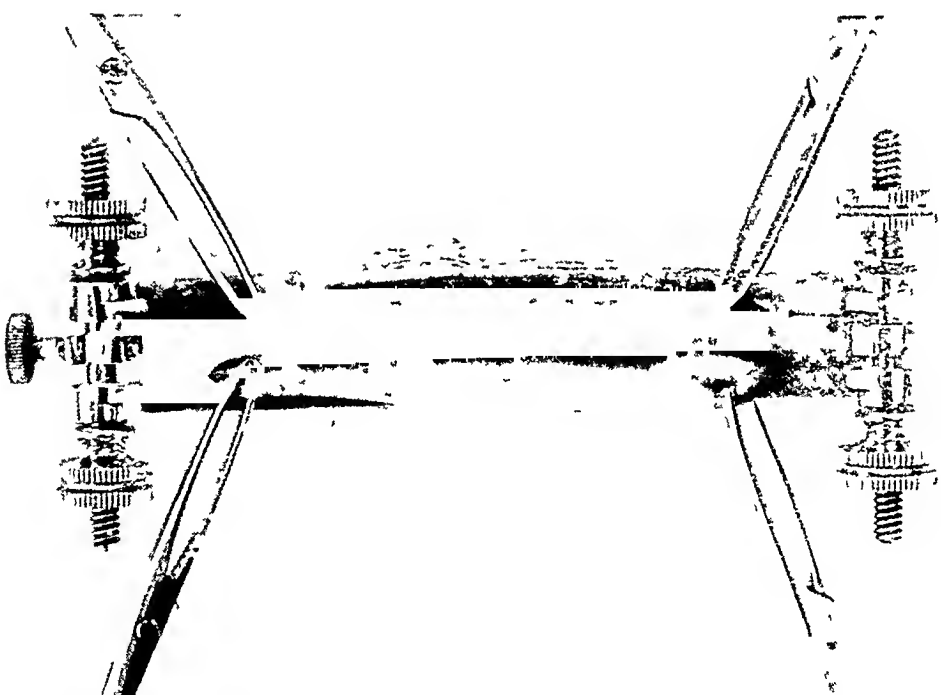


FIG 2.—The clamp in place, portions of stomach and jejunum being adjusted within the jaws



FIG 3 —The clamp fully adjusted note the control of equable pressure by the four set screws

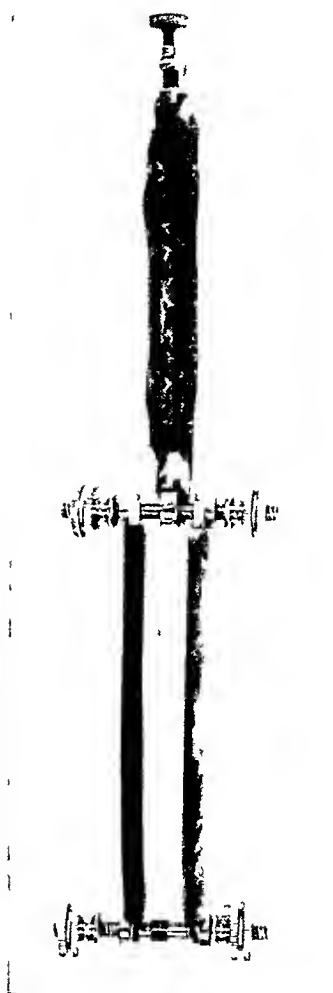


FIG 4 —The operation completed the instrument unlocked the side bars swung back and the centre bars ready to be disengaged

ble operators will elect to perform the operation with a Bartlett aluminum clamp, with the Scuddei fenestrated stomach forceps or with the Payr flexible intestinal clamp. Murphy used no clamp whatever, but performed the operation with the aid of a rectangular button. Some surgeons will use no mechanical device as an aid. As a general thing, however, the operation can be far more perfectly performed with the aid of some device which will satisfactorily control the hemorrhage and the flow of gastric and intestinal contents. An instrument which will do this and at the same time will steady and support "the work," as an engraver would say, will prove of value to any surgeon and is bound to make the operation more satisfactory and far easier of accomplishment than if it were performed without such aid.

The Roosevelt clamp accomplishes nearly everything that can be desired of a gastro-enterostomy instrument, and although its popularity is thoroughly justified and it is probably the most widely used instrument of all, yet it has its defects. It is impossible to maintain an equable pressure through the length of its jaws. It has a pair of long weighty handles that drag upon the stomach and intestines. The pressure upon the stomach and bowel is controlled only at two points when it should be adjustable at four and, because of its peculiar construction, the pyloric portion of the stomach is occasionally prone to slip from its grasp.

In the experimentation performed with various models and which has resulted in evolving the instrument I am at present using, the attempt has been to produce a light, easily applied, accurately fitting clamp producing an even parallel pressure between its jaws and so arranged that this pressure may be accurately adjusted to a nicety at four points. Ease of removal at the completion of the operation has also been a factor considered in designing the instrument. The clamp has the general shape and curvature of the Roosevelt, as will be seen (Fig 1). It consists of a central bar and two side bars controlled by four knurled nuts. The central section is slotted to receive a square shoulder cut at the centre of one of the transverse screws and held in place by a small set screw. The two side members can be swung through a circle of 180 degrees, facilitating the rapid removal of the instrument on the completion of the operation. The instrument is constructed of steel except for the nuts, which are of brass, and for the screws which, double threaded, are of Monel metal to prevent corrosion. In using the instrument rubber tubing is first slipped over the three sections as is done with the ordinary Roosevelt clamp. Portions of the stomach and jejunum are approximated and are drawn through the instrument by means of Allis forceps, as shown in Fig 2, or by means of traction sutures. Delicate adjustment of the stomach and bowel can be brought about with great facility and accuracy with this apparatus, the application of the pressure being readily under the control of the four screws. Fig 3 shows the stomach and the jejunum approximated and secured in the clamp ready for the first row of serous sutures.

Fig 4 shows the operation completed, shows the instrument unlocked, the side bars swung back, and the centre bar ready to be slid from beneath the anastomosis. The early models were hand forged for me by Harvey R. Pierce & Company, of Philadelphia, and recently the completed instrument has been placed in stock by that manufacturer.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Regular Meeting, Held February 25, 1920

The President, DR WILLIAM A DOWNES, in the Chair

DEPRESSED FRACTURE OF THE SKULL, HÆMIPLEGIA, RECOVERY

DR FREDERICK T VAN BEUREN presented a boy ten years of age who was admitted to the Roosevelt Hospital November 10, 1919, at 10 30 P M , with the history that while walking along the street something had fallen and struck him on the head. At the time of admission he was conscious and no paralysis was noted. There was free bleeding from the scalp wound. The temperature was 99° F, pulse 120, and respirations 32. There were clonic spasms involving the right arm and leg, slight in degree and lasting about ten minutes. Motion and sensation were normal so far as could be determined. There were no pupillary symptoms, no facial paralysis, and the knee-jerks were present and normal.

There was a depressed fracture of the vault of the skull over locomotor area of brain. Immediate operation was performed, with the patient under ether anæsthesia 45 minutes and in the prone position. The depressed fragments were elevated and removed, with extreme care, after debridement of scalp. The depression had a diameter of about 3 cm and a depression of about 1 cm. The inner table was fractured to a considerably greater extent. Although great care was exercised in the removal of the fragments by cutting around them with rongeur, the dura was found to be lacerated, the laceration being linear and extending from before backward. As the dura pulsed normally it was not opened. The wound was closed, leaving a small area in the centre for drainage. The boy was sent back to the ward in good condition. The following morning there was voluntary paralysis of the right arm and paræsthesia. Sensation of pain, pressure, touch, position, heat and cold were present, but slowed down in perception. The reflexes were diminished at the elbow and wrist. Passive motion was sometimes faintly opposed by involuntary action. Sensation and motion in the right leg were normal.

Doctor Tilney was then called in on November 12th to examine the boy and noticed a slight flattening of the right side of the face. There was complete loss of voluntary motion in the right arm, the reflexes absent included the biceps, triceps, pectoral and wrist. The left arm was normal in strength and reflexes. The abdominal reflexes were active and equal. Knee-jerks were more active in the left than in the right leg. There was no Babinski

or clonus The strength of the right leg was less than that of the left Sensation was normal The pupils were active and contracted to light The tongue protruded in the mid-line

On November 14th the reflexes were still absent in the right upper extremity, and it was slightly spastic There was an increase in strength in the right leg, but no changes in the reflexes

On November 18th, eight days after the operation, the nurse noticed slight active movement of the right arm while massaging it Movements were awkward and fumbling and stronger in flexion and pronation than in extension and supination The following day they had improved slightly in strength and purposefulness, but were still quite feeble and poorly coordinated The patient looked brighter and had improved in general appearance There was still a slight right facial paralysis, barely noticeable except in the branch to the lower lip The movements of the head and neck were apparently comfortable and quite free The tenderness and œdema of the scalp had practically disappeared The discharge from the wound which had been free from the second or third day post-operative had become much less and the defect in the wound was smaller There was still some sloughing and granular material in this fluid could be expressed from beneath the lower flap The right arm, though still held in flexion at the elbow and with pronation of the forearm, was capable of almost all motions in some degree Flexion of the fingers was poor and extension very poor, being spasmodic and incomplete, and adduction and abduction were absent All the movements were poorly coordinated, irregular in degree, and could not be sustained Reflexes and sensation were practically normal The reflexes of the right leg were normal and the strength almost equal to that of the left leg

On November 19th the triceps and biceps reflexes of the right arm were all present and also those of the wrist and ulna There was very slight ankle clonus of the right leg, and the strength was nearly normal The fingers could be moved in flexion and extension There was a slight degree of wrist drop of the right hand Flexion and extension of the right forearm was also noted

On November 21st the finger movements had distinctly improved The movements of the index and middle finger phalanges were almost completely regained, and the other movements were growing stronger

November 23rd the action of the interossei, previously absent, could be noted, though it was incomplete The extension of the fingers was much better, the fourth and fifth fingers could be extended Extension of the wrist which was almost absent three days before had markedly improved All motions were much better coordinated

He was discharged from the hospital December 10th, and had continued to improve until the residual loss of motion was very slight, amounting, three months after injury, to inability to adduct the little and index finger of the right hand Motions are still a little awkward and strength of the right hand a little less than normal

GASTROJEJUNAL ULCER

Examination of the site of the injury shows the existence of a very large defect of the cranial wall. The boy would require very careful watching, especially as there had been laceration of the dura, on account of the possible subsequent development of Jacksonian epilepsy.

TUBERCULOUS TUMOR OF CAPSULE OF KNEE

DR HAROLD NEUHOF presented this patient, a woman, twenty-eight years old, who came under observation six years ago with an enlargement about the knee-joint of one and a half years' duration. There was a considerable effusion into the joint with marked limitation in motion. The striking feature was a large painless mass deeply situated under the vastus internus and apparently contiguous with the joint. Aspiration of the joint disclosed clear fluid which was negative upon animal inoculation. X-ray examination showed the picture of a chronic osteo-arthritis. The preoperative diagnosis was a fascial sarcoma.

At operation in February, 1914, a longitudinal incision was made over the mass under the vastus internus, which upon exposure was interpreted as a neoplasm springing from the joint capsule. This was widely excised. The synovial membrane of the joint being freely sacrificed about the tumor to which it was adherent. No lesion was seen within the joint itself other than a rather spongy appearance of the synovial lining. The wound was closed in layers.

A microscopic examination of the specimen showed a typical tuberculosis of fibrous type. The attached portion of the synovial membrane was free from any microscopic evidence of tuberculosis. An immobilizing splint was employed, with interruptions, for about a year and was then discontinued. There is now moderate limitation in flexion and extension of the joint, and a recent X-ray shows a slight degree of chronic osteo-arthritis. Occasional pain after standing for long periods is the only symptom of which the patient complains. At no time has there been any evidence of recurrence or of tuberculous involvement within the knee-joint.

GASTROJEJUNAL ULCER

DOCTOR NEUHOF presented a young man, aged twenty-four years, who came under observation in Bellevue Hospital in April, 1919, with a history of pyloric stenosis of many months' duration. Because of the extreme emaciation a provisional diagnosis of pyloric carcinoma was made. At operation, a transverse abdominal incision was made. There was a large saddle-shaped ulcer of the pylorus, extending into the first portion of the duodenum. The pylorus appeared completely stenosed. The stomach was greatly dilated and atonic. The general condition of the patient appeared too poor for excision and a posterior no-loop gastrojejunostomy was made. The usual four-layer suture was employed, chromic gut for the inside and fine linen thread for the outside. The transverse mesocolon was fixed to the gastric wall in the usual way. Convalescence was

smooth after operation, vomiting ceased and the patient rapidly gained weight and strength. He felt perfectly well until five months after operation.

Epigastric pain then began, occasionally accompanied by vomiting. These manifestations became more severe and the patient again began to lose weight. X-ray examination showed a patent gastrojejunostomy but considerable retention as well. There was a second operation in October, 1919, that is, about five months ago. At operation, through a vertical abdominal incision, only a small area of induration was found at the pylorus where previously the saddle-shaped ulcer had been. The pylorus was partly open. The mesocolon was contracted about the gastrojejunostomy, apparently as a result of the adjacent inflammation. At the gastrojejunal stoma, there was a large area of dense infiltration with crater-like margin almost exclusively situated in the wall of the stomach. It completely, or almost completely, encircled the anastomosis, extending only slightly into the jejunum. The largest diameter of this ulcer was about 8 cm. The stoma appeared patent, but to what degree could not be determined. The gastric wall was uninvolved beyond the sharp confines of the ulcer.

Several alternative procedures offered themselves for the treatment of the condition that was encountered. First, to sever the anastomosis, excise the ulcer, and reimplant. This was rejected because of the extensive size of the ulcer and shortened mesocolon, and also because of the general condition of the patient. Another procedure was to divide the jejunum at both sides of the anastomosis and reimplant. This was thought to be too difficult because of the very short afferent portion of jejunum. The following procedure was employed. A long loop anterior gastro-enterostomy was done, chromic gut sutures being used throughout, the anastomosis was placed near the greater curvature and to the pyloric side of the gastrojejunal ulcer. The length of the loop was about 25 cm. The entrance of the afferent portion of jejunum into the posterior gastro-enterostomy was then occluded by a silk ligature tied tightly in place. The efferent portion of the jejunum from the old anastomosis could not be treated in a similar fashion because of the possibility of regurgitation into it from the anterior gastro-enterostomy. At the same time it appeared desirable to avoid regurgitation from the new into the old anastomosis. In the effort to avoid this and to avoid as well stasis in the duodenum, a side-to-side anastomosis was made between the ascending limb of jejunum going to the new anastomosis and the portion of the jejunum to the proximal, that is, gastric side, of the occluding silk ligature. A Murphy button was used for this purpose. Convalescence after operation was smooth. Only after operation was concluded did the writer consider the fate of the Murphy button. It then appeared to be inevitable that the button would be passed into the stomach. However, by good fortune the button was passed in the stool on the ninth day. Pain disappeared shortly after operation and has at no time recurred. Vomiting has not recurred. Appetite is good and the patient has gained steadily in

weight There has been no gastric retention in the examinations made since operation, and the patient appears entirely well at the present time

DR JOHN F ERDMANN said a point of interest in this case was the excision of an ulcer at the second operation He had fortunately or unfortunately had to do quite a number of revisions following gastro-enterostomy This was because some of these subjects were ulcer bearers, and no matter how thoroughly an ulcer was excised there would be a recurrence He recalled one instance in which he found an ulcer at the first operation and did the Polya operation Subsequently there was a recurrence and he did a resection of the jejunum at the anastomosis site, then a jejunojejunostomy, and a gastrocolostomy, later there was another recurrence In another patient he had operated at three different times for recurring peptic ulcer in the immediate vicinity of a gastrojejunostomy opening Some ten or twelve similar cases had come under his observation, one in which the colon, jejunum and stomach were all anastomosed Some of these ulcer cases were certain to have recurrences in the course of eight or twelve months As to suture material for five or more years he used absorbable suture material, chromic catgut, altogether, except in the transverse mesocolon

DOCTOR DOWNES said he had reported two cases of gastrocolic fistula following gastro-jejunostomy some time ago In one of the cases, in attempting to separate the colon from the stomach and jejunum, he found he had removed so much of the jejunum that it was necessary to do an end-to-end anastomosis, and he wondered whether or not Doctor Neuhof could not have done a resection Doctor Downes said he was afraid if there should be a recurrence in Doctor Neuhof's case he would have considerable difficulty in getting things straight

DOCTOR ERDMANN said that when he first attempted the revision following a gastro-enterostomy for peptic ulcer in the vicinity of the gastro-enterostomy opening, the procedure looked like a rather formidable undertaking, but after having done it once he found it very easy and rather enjoyed that type of operation now

SPINAL-CORD TUMOR

DOCTOR NEUHOF stated that this patient, forty-seven years of age, had had what he described as rheumatism about the left shoulder for some eight years About fifteen months ago (November, 1918) he began to experience lancinating pains in the third, fourth and fifth fingers of the left hand Subsequently there was similar pain down the left lower extremity He then noted difficulty and stiffness in walking with dragging of the left leg Difficulty in urination developed at a later stage All the symptoms were progressive, especially the pain radiating into the left hand

A resumé of the physical examination upon admission to the Montefiore Home consisted in unequal pupils, the left smaller than the right, atrophies in both upper extremities, chiefly in the left hand, spastic gait with exaggerated and abnormal reflexes, ankle and patellar clonus The interesting feature

of the neurological examination was the vague and indefinite level area of hyperalgesia which was varyingly located from the upper cervical to the upper dorsal segments at examinations made at different times. Lumbar puncture established the indication for operation, for a yellow fluid was withdrawn which promptly clotted on standing.

At operation, on September 18 (five months ago), the spines and arches of the fourth, fifth and sixth cervical vertebræ, and subsequently those of the third and seventh, were removed in the usual way. Upon opening the dura, a cystic portion of the tumor at once presented. Posterior roots could not be seen and for some time it was difficult to determine whether or not the tumor was an intramedullary one that had broken through the cord. By gently tugging on the cystic cap of the tumor the upper pole was dislodged from underneath the arch of the second cervical vertebra. The lower pole could then be dislocated and the whole tumor slipped free. It manifestly arose from the pia-arachnoid. Its attachments were two posterior roots that were sacrificed and a vascular pedicle springing from the posterior spinal vessels. This was tied off. Nevertheless, the base of the pedicle oozed freely. Bleeding was promptly controlled by a postage stamp graft of a small fragment of muscle. The cord was found extensively flattened, more so on the left than on the right side. Wound was closed in layers in the customary manner, and a board splint applied.

The tumor was unusually large, 8 cm. long and about $2\frac{1}{2}$ cm. in diameter. It presented a number of cystic excrescences and for the rest was of jelly-like consistency. Upon section the cysts were found to be occupied by clear or bloody fluid. Microscopic examination showed an endothelioma with cystic and hemorrhagic degeneration.

Convalescence was smooth. The patient was immediately free from the pain of which he had complained and has remained free up to the present time. There has been gradual improvement in power in the left arm and hand. The right upper extremity is practically normal, and there has been marked improvement in the spasticity of the lower extremity. Urination is normal. There is no discomfort following removal of the cervical bony arches.

The interesting feature is the large size of the tumor producing relatively slight manifestations because of its semi-fluid consistency.

OSTEO-ARTHRITIS

DOCTOR NEUHOF presented a man, aged forty-eight years, whom he wished to show in connection with the question recently raised at this society of early mobilization after knee-joint operations, as well as to indicate the possibility of operative relief in some cases of osteo-arthritis. Operation had been done too recently to consider the possibilities of the ultimate result. The patient complained of pain and stiffness in the right knee which began about a year ago. The symptoms had become progressively worse, the patient soon being unable to stand any length of time. Pain was always increased by attempted motions at the joint. Treatment consisted in mas-

SARCOMA OF THE STOMACH

sage, bakings, and vaccines for supposed focal infection in the teeth Extensive dental work was carried out

Physical examination at the time of admission to Bellevue Hospital showed the joint considerably enlarged and tender There was about three degrees of motion up to extension of approximately 160 degrees Over the inner aspect of the knee the skin appeared drawn in upon flexion of the joint, leading to the assumption of some limiting bands within the joint The X-ray showed the picture of a chronic hypertrophic osteo-arthritis An exploratory arthrotomy was suggested, an etiological diagnosis not having been made

At operation, one month ago (January 25th), a long curved incision was made just mesial to the inner border of the patella The patella was retracted externally, but could not be dislocated beyond the femur and flexion of the joint could not be carried out The disease within the joint was almost entirely limited to its inner aspect The synovial membrane was thickened and discolored, but smooth The inner border of the patella was sharply lipped Grayish excrescences of the tibia and femur were visible through the synovial membrane The menisci were not diseased The most striking feature of the joint pathology was a broad band of adhesions extending from the tibia, anterior to the crucial ligaments, to the intercondylar notch of the femur Upon attempting flexion of the knee this was put upon the stretch, and only after its excision, free flexion of the knee with dislocation of the patella were possible The ligamentum alaria was converted into a thick fibrous mass covered by many pedunculated villi It was almost completely excised There were many other pedunculated and sessile villi which were excised The lipped internal border of the patella was removed with rongeurs The wound was then closed in layers, and a posterior moulded splint applied

Passive motion was begun the day after operation, and on the second day active motion was begun This was increased by the patient under careful supervision The splint was discontinued after one week Patient was permitted to walk three weeks after operation He is now free from pain, walks considerable distances, not using a cane for support At the present time flexion exists to 90 degrees and extension to about 160 degrees, without any discomfort within this range of motion The range of motion is progressively increasing

SARCOMA OF THE STOMACH

DR JOHN DOUGLAS read a paper with the above title, for which see page 628

DOCTOR ERDMANN recalled that ten or possibly eleven years ago, he had removed a sarcoma of the stomach and at the same time removed a section of the ileum for sarcoma The pathologists were not satisfied as to which growth was primary, the one in the stomach or the one in the ileum The patient was brought for a beginning intestinal obstruction, and a large sized tumor was found partially obstructing the lumen of the ileum A resection

was done six or eight inches above the ileocaecal valve. In the course of further exploration at the time of operation the growth in the stomach was discovered. Within a week or two he had heard that this patient had died recently and from what he had heard he understood that influenza had caused his death.

A second patient was a male, aged forty-six years, a prominent actor, from whom he removed about one-half the pyloric end of the stomach for an exogastric sarcoma. This patient was operated upon about six years ago, and died recently of what Doctor Erdmann was unable to report.

DOCTOR FISCHER presented a specimen of sarcoma of the stomach which was removed from a patient forty-four years of age who had never been sick before. Her present trouble first manifested itself only four weeks before she came under observation, when she noticed that her abdomen was increasing in size. She was first admitted to the medical ward and later an exploratory laparotomy was done. It was found that she had a large retroperitoneal tumor, probably originating from the kidney. The condition was inoperable and she died a week later. At postmortem a large sarcoma of the stomach was found. Her blood had shown 70 per cent hæmoglobin, there was no obstruction of the pylorus, and no anæmia. In fact, there were no clinical stomach symptoms whatever.

Autopsy Report—Upon opening the abdomen 300 cc of opaque chocolate-colored fluid escaped. Uterus normal, right ovary and tube atrophic, with cystic degeneration of the ovary. Left ovary absent. Bladder and capsules strip easily, marking slightly accentuated. Spleen. Slightly larger than normal, marked perisplenitis. Liver large, very pale, and waxy and firm on section, with obscure markings. Pancreas normal. With the exception of the stomach, the gastrointestinal tract is normal. Upon opening the abdomen a pear-shaped mass, reddish-yellow in color and semi-fluctuating consistency, presented itself at the usual location of the stomach, but between the leaves of the mesentery of the transverse colon, this mass was subsequently found to measure 21 x 25 x 23 cm in diameter and to weigh 11 pounds. Upon dissection it was found that the neoplasm had grown from the left wall of the stomach, the greater curvature having assumed the perpendicular position. A circinate ulcer, measuring 5 cm in its greatest diameter, was found 3 cm from the pylorus, the base of the ulcer being the tumor previously described. Aside from this ulcer the mucosa of this organ appeared to be normal. On section the tumor was found to be markedly degenerated, with numerous areas of cyst formation. The microscopic examination showed a tumor mass of small spindle cells arranged radially about the small blood-vessels, with many mitotic figures, invasion of the gastric musculature, liver and omentum, and many blood emboli. The anatomical diagnosis was sarcoma of the stomach.

ULCERATING FIBROMA OF STOMACH SIMULATING MALIGNANCY

DR DEWITT STETTIN presented a man, sixty-six years of age, who consulted his physician complaining solely of a feeling of general malaise. He had no gastric or intestinal symptoms and there was no marked loss in weight. A systematic routine examination revealed a moderate secondary anæmia, the blood count being as follows: Red blood-cells, 3,950,000, hæmoglobin, 70 per cent, white blood-cells, 8400, polynuclears, 70 per cent, large



FIG 1 —Radiograph of stomach shortly after meal, showing persistent defect at greater curvature, indicated by arrow



FIG 2 —Tumor covered by mucosa showing larger ulceration at apex of tumor

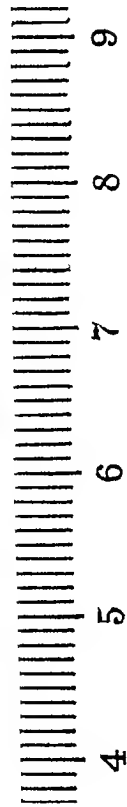
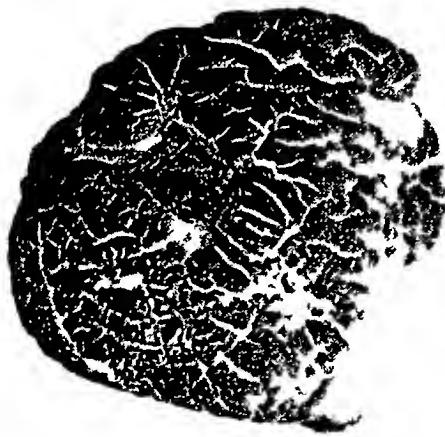


FIG 3.—Tumor covered by gastric mucosa showing smaller ulceration at side



FIG 4.—Microphotograph from section of tumor. Note position beneath submucosa and character of interlacing bundles of fibrous tissue. Muscle fibres of the muscular coat are seen running through the tumor tissue. Magnified 20 diameters

ULCERATING FIBROMA OF THE STOMACH SIMULATING MALIGNANCY

lymphocytes, 4 per cent, small lymphocytes, 26 per cent. In order to discover the cause of the anæmia the gastro-intestinal tract was carefully gone over. The stool on a meat-free diet showed blood, strongly positive. The string test showed a blood stain 16 inches from the teeth. The gastric contents showed free HCl, 60, total HCl, 84, and blood, positive. A radiographic examination of the stomach showed a definite and persistent defect at the greater curvature, nearer the pylorus. It was of fair size, somewhat triangular in shape and of irregular outline. The sides of the triangle measure about 4 cm. in the plate. The probable diagnosis of malignant disease of the stomach at the greater curvature was made and operation advised.

The operation was performed on January 26, 1917. On inspection the stomach showed no definite evidence of disease. On palpation a slightly pedunculated mass was felt at the greater curvature nearer the pylorus corresponding to the defect shown in the X-ray plate. It was round, hard, rather smooth and about the size of a walnut. There were no glands. It impressed me as a benign growth and I made a wedge-shaped excision and then closed the stomach wound.

The tumor was a hard, rounded mass under the submucosa, and measured about 3 x 3 cm. It had an indistinct, fibrous capsule. On section the tumor presented a firm, somewhat reddened, fibrillated structure. A rather surprising feature was the following. On the apex of the growth a large, round, punched-out ulcer had formed of about 1.5 cm. in diameter and laterally another smaller ulcer, about 0.5 cm. in diameter and of the same character, was discovered. At these ulcerated areas the mucosa was completely destroyed, exposing the tumor.

Microscopic examination of sections of the growth, stained by hæmatoxylin and eosin and by Van Gieson, showed it to be composed of large numbers of interlacing bundles of elongated, fairly mature fibroblasts. The nuclei are in the main rod-shaped. At one point muscle fibres from the muscular coat of the stomach run through the tumor tissue. In places a connective-tissue capsule can be demonstrated. The tumor is undoubtedly benign and must be classed among the fibromata, which according to Aschoff are usually of perineural origin.

The patient made an uneventful convalescence and according to recent report is in the best of health. His living out of town prevented my showing him here this evening.

CORRESPONDENCE

FRACTURE OF THE OS NAVICULARE PEDIS

EDITOR, ANNALS OF SURGERY

Mrs T Z, aged twenty-five years, seen first on February 17, 1920, at which time the following history was obtained. The previous night, while leaving the theatre, the heel of the left foot was caught in the runway, causing the foot to twist sharply outward. The patient experienced a sudden sharp stab of pain in the foot, followed by immediate disability, necessitating aid to enable her to reach her home. The next morning I examined the case and noted the following. Left foot presented a distinct, localized prominence over the inner and upper part of the scaphoid. The part was very red and intensely painful and tender. In fact, the symptoms were so marked that no attempt was made to obtain crepitus. A tentative diagnosis of fracture of the navicular was made. The radiographic report (Fig 1) confirmed the diagnosis and also defined the good apposition of the fragment. Considering this, no further attempt to obtain crepitus was made. A pad of heavy saddler's felt was strapped over the site of injury and a plaster-of-Paris case applied, extending from the toes to midway up the leg. The foot was maintained in a position of inversion and at a right angle to the leg. At present writing the bone shows good union with no subjective symptoms except for a feeling of tiredness when she overexerts the part.

A study of the literature shows how very uncommon this lesion is. Stimson was able to collect a total of seventy cases, including a series of twenty-two, reported by Finsterer. Scudder dismisses the entire subject with the remark that this fracture is caused by direct violence. Walton, writing on fractures and separated epiphyses, barely mentions the topic. Bloodgood, Speed, and Moorhead all speak of this trauma as rare. Moorhead, in his book on Traumatic Surgery, collected a large number of various bone fractures, taken from a number of New York City hospitals. He obtained a total of 5028, of which he states that the tarsus were fractured forty-seven times but does not individualize them. In other words, isolated fracture of the scaphoid was not apparently met with. I say this because of the fact that in a series of 115 cases of fracture, observed by the same writer, in a period of one year, he does list isolated tarsal injuries (One case of fracture of the cuboid). In a personal study of the statistics of all the fractures at the Hospital for Deformities and Joint Diseases, for the past two years, I was able to gather a total of 774 cases. No single case of fracture of this bone was found.

Without the aid of X-rays the diagnosis is presumptive, especially so if no displacement of the fragment occurs. Stimson goes so far as to state that two-thirds of the cases are unrecognized, after long intervals,



FIG 1 —Fractured scaphoid bone of the foot

until radiographed. An X-ray usually makes for a positive diagnosis. Occasionally, one may be deceived by the presence of the os tibiale externum, one of the supernumerary bones of the foot. The usual sites of fracture of the navicular are through the body of the bone or at the base of the tubercle.

Treatment of this type of injury should be directed toward maintaining the future static function of the foot, particularly so, since this bone is in direct line of weight-bearing. It might not be amiss to recall the fact that attached to the under surface of the navicular is the so-called "spring ligament," commonly known as the inferior calcaneo-scaphoid ligament. This structure performs the important duty of supporting the astragalus, thereby acting as the principal mainstay in upholding the longitudinal arch of the foot. An injury severe enough to result in a fracture of the bone, one must assume, will inflict damage on this underlying structure. With this anatomical reason in view, inversion of the foot should be maintained at all times. This position tends to prevent a future traumatic flat foot and at the same time permits of no undue tension on the injured ligament. Inability to maintain reduction of the fragment, when displacement recurs, calls for operative interference. It is good policy to use a corrected shoe, with an elevation of one-quarter of an inch on the inner border of the heel. This will prevent secondary strain.

The final results are good. A small prominence may remain. Six weeks is a fair estimate for full functional recovery.

I REITZFELD, M D
New York City

DUODENAL HEMORRHAGE DUE TO SUTURE

EDITOR, ANNALS OF SURGERY

The case herein reported merely confirms what is already known, namely, that the use of silk or non-absorbable material in stomach or intestinal surgery is attended with a remote possibility of a serious complication, in the nature of an obstruction, secondary ulcer, or hemorrhage.

The patient, an adult male, in August, 1912, shortly after a hemorrhage from the stomach, submitted to an operation, and was told by his surgeon that an ulcer was found in the duodenum and was turned in by a purse-string suture. January 16, 1913, he applied to Dr. Wm. Gerry Morgan for treatment, stating that he was having tarry stools. He had no pain or retention and his health seemed unimpaired. At this examination the pulse was 96, soft in quality, blood-pressure 130-90, gastric contents showed mucous pus, free HCl 52, total acidity 64, blood

February 11, 1913, the hæmoglobin was 55, red blood count 5,360,000, white blood count 8500. The urine showed a few casts and a trace of albumen. The roentgenologist reported an incisura and contracted pyloric end of the stomach, cap normal, no six-hour residue. Benzidine test for

blood in fæces was four plus. About one month later the hæmoglobin was 37, red blood count 4,000,000, and white blood count 7000. He went abroad in the autumn of 1913 and returned much better, his hæmoglobin being 81.

In May, 1914, the tarry stools recurred and blood was present in his stools in December, 1914. The patient then passed from under the observation of his physician but returned on December 17, 1917. In the interval he relates he was operated upon, a gastroenterostomy having been done. At the examination in December, 1917, the stools were black, blood present (benzidine test four plus), and the patient anæmic. The hæmoglobin was estimated frequently at this time, and the lowest reading was 24. The patient was losing blood with every movement and growing weaker from day to day. He was removed to Garfield Hospital December 26, 1917, and operated upon the following day.

Operation—High median incision revealed moderate omental adhesions to abdominal wall. The stomach and duodenum were exposed, inspected and palpated, but no ulcer was discovered. The stomach was opened and explored, an especial search being made for a jejunal ulcer, but the gastroenterostomy was patulous and perfectly healed. The stomach was closed without finding the source of the hemorrhage. A re-examination of the duodenum revealed a narrow black object, which on grasping with forceps, proved to be one end of a silk suture about $1\frac{1}{2}$ inches long. A few shorter pieces were removed. The area did not have the appearance or induration of an ulcer. The pylorus was plicated with chromic catgut and the abdominal wound closed.

The patient has remained well over two years since the silk suture was removed, which would seem to establish a definite relation between the hemorrhage and the suture, but whether the silk maintained an ulcer, acting as an irritant, or whether the gradual unfolding of the duodenum was lacerated by an unyielding suture matters little in the final deduction.

CHARLES S. WHITE, M.D.,
Washington, D. C.

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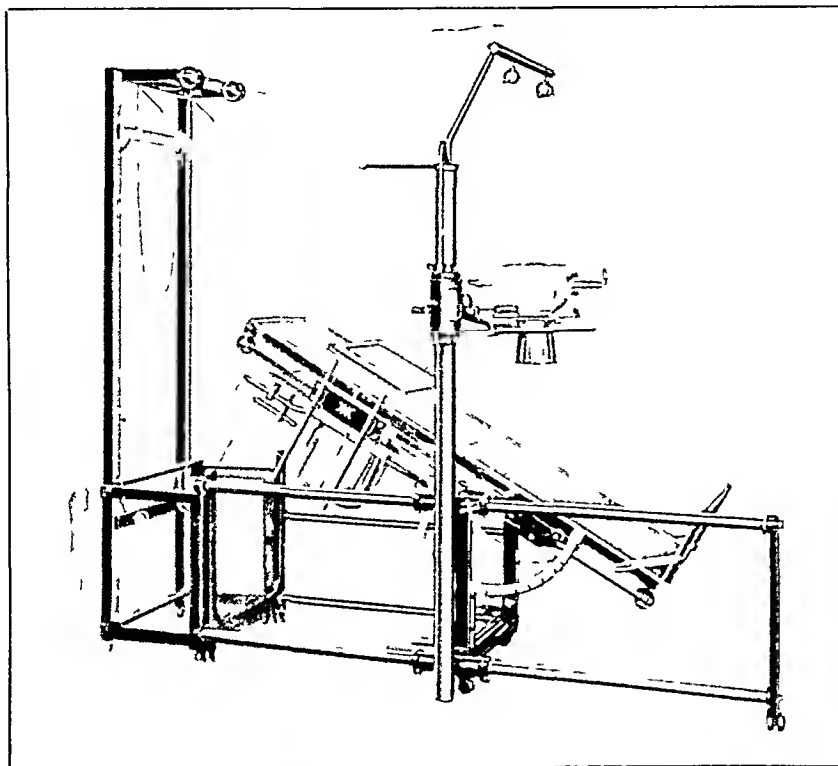
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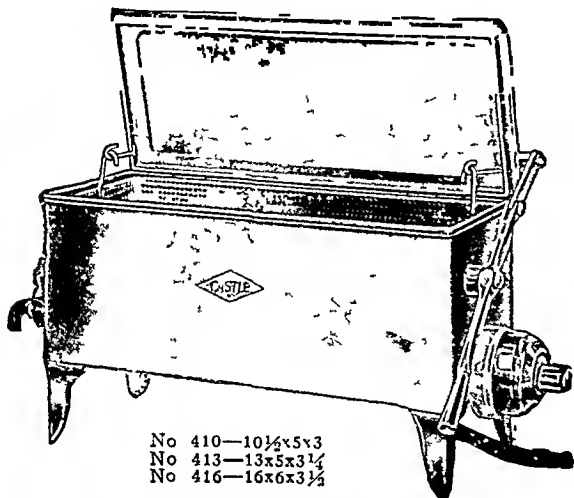
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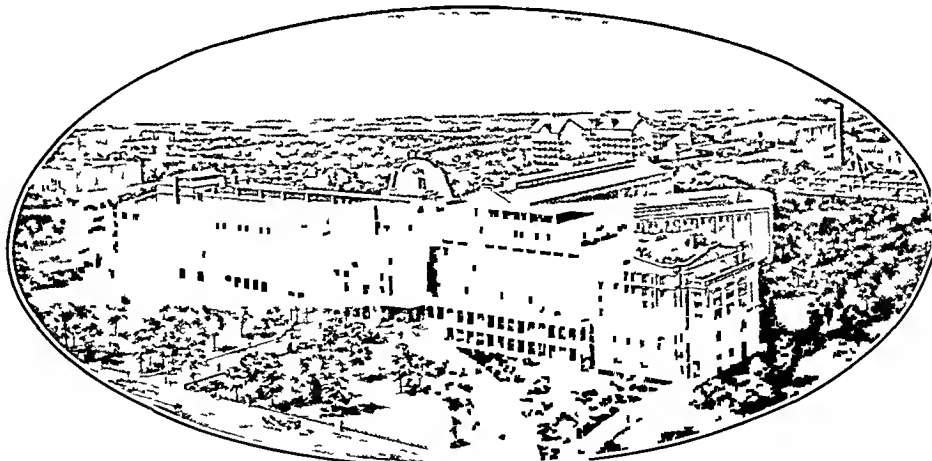
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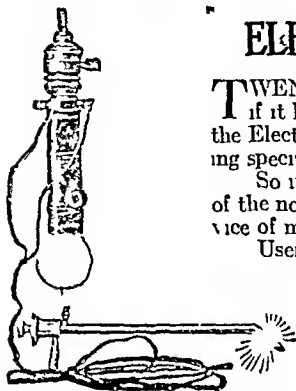
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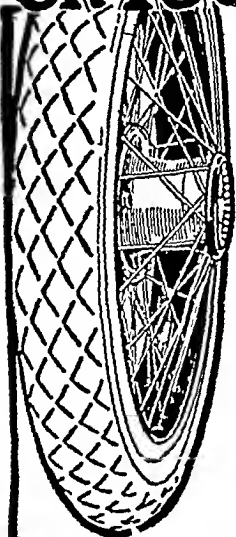
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31x3½	13 10	14 40	3 30	35x4½	28 20	30 70	5 70
32x3½	14 30	16 20	3 40	36x4½	28 60	31 15	5 90
34x3½	15 10	16 70	4 15	37x4½	32 65	35 00	6 70
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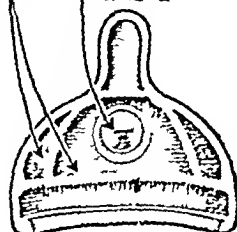
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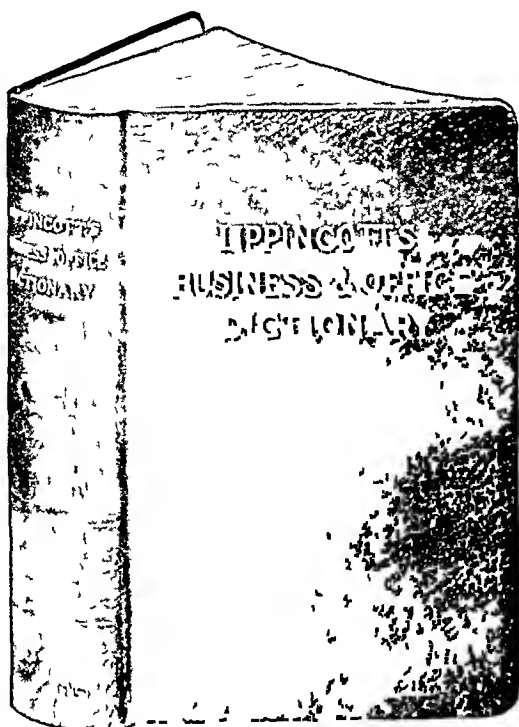
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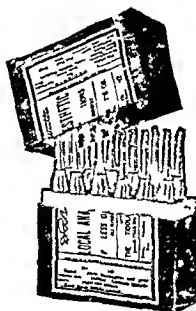
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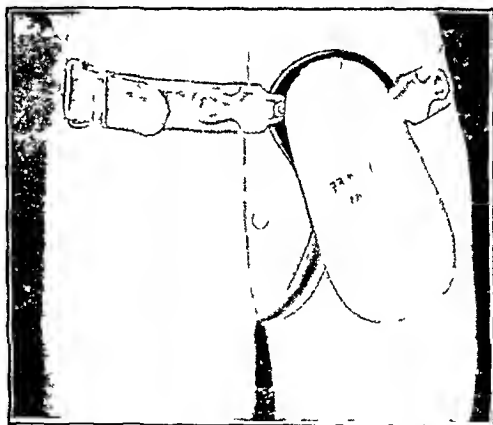


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